Harris County Truck Route Study

Phase I Report

Prepared for

Harris County Engineering Department

Prepared by

Dannenbaum Engineering Corp.

In association with

Cambridge Systematics, Inc.

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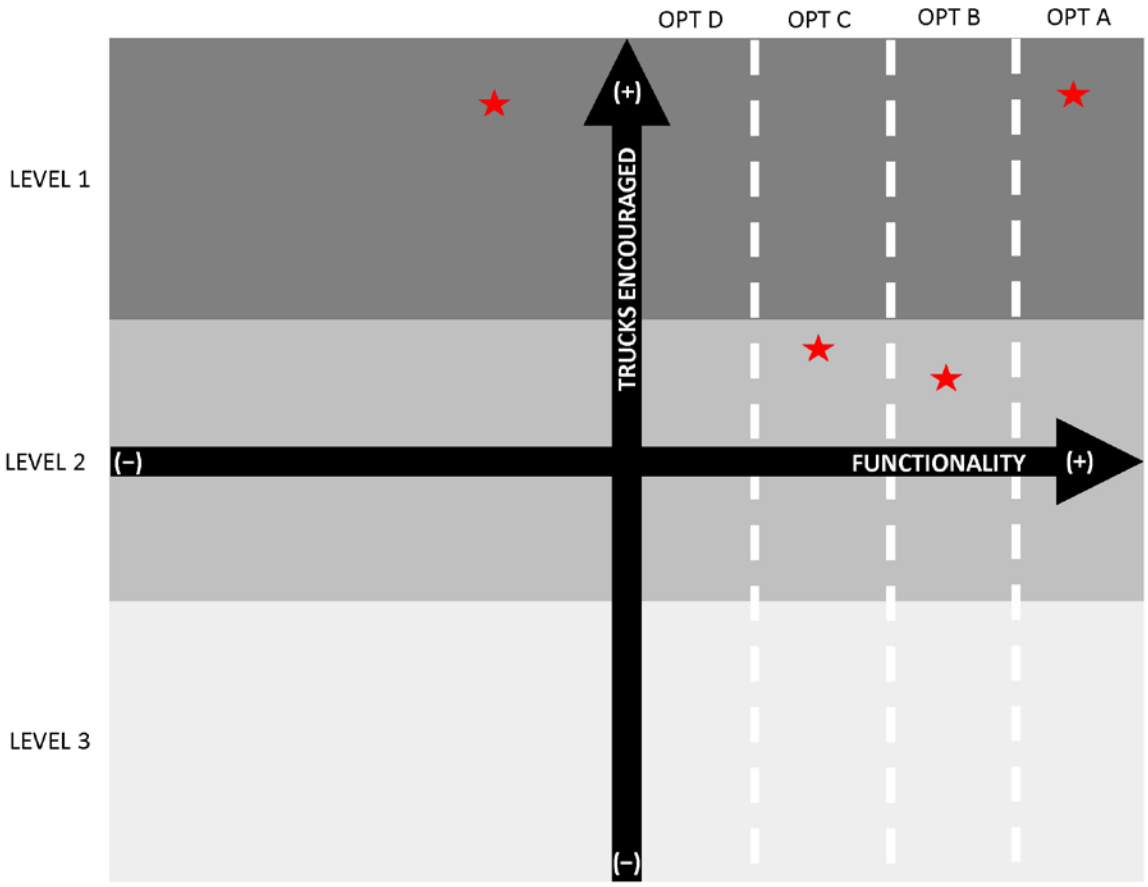
Executive Summary

Harris County's motivation for this Study was to identify appropriate routes for investment that would serve the needs of the business community and enhance the efficient flow of truck traffic in the region. Because Harris County does not control any roads in the City of Houston and controls only a limited number of roads in the areas surrounding the Port of Houston, this network must be integrated with and connect to TxDOT's Highway Freight Network, municipal truck route networks, and the regional truck route network developed for the Houston-Galveston Area Council (HGAC).

This Study used a two-step approach to produce a Draft Truck Route Network and identify potential infrastructure projects. The first step, explored in Section 2, identified route suitability through a planning-level analysis of County land use patterns, population, road characteristics, network connectivity, and truck origins and destinations, among other considerations. This approach identifies the need for a truck to use the road.

The second step, examined in Section 3, explored route functionality using an engineering-level analysis of factors including bridge and pavement condition and weight carrying capacity, lane width, etc. This approach identifies the ability of a truck to use the road in its current condition. This two-step analysis can be thought of as a matrix, shown in Figure ES.1 below, with the route suitability shown on the Y-axis and route functionality shown on the X-axis.

Figure ES.1 Harris County Truck Route Matrix

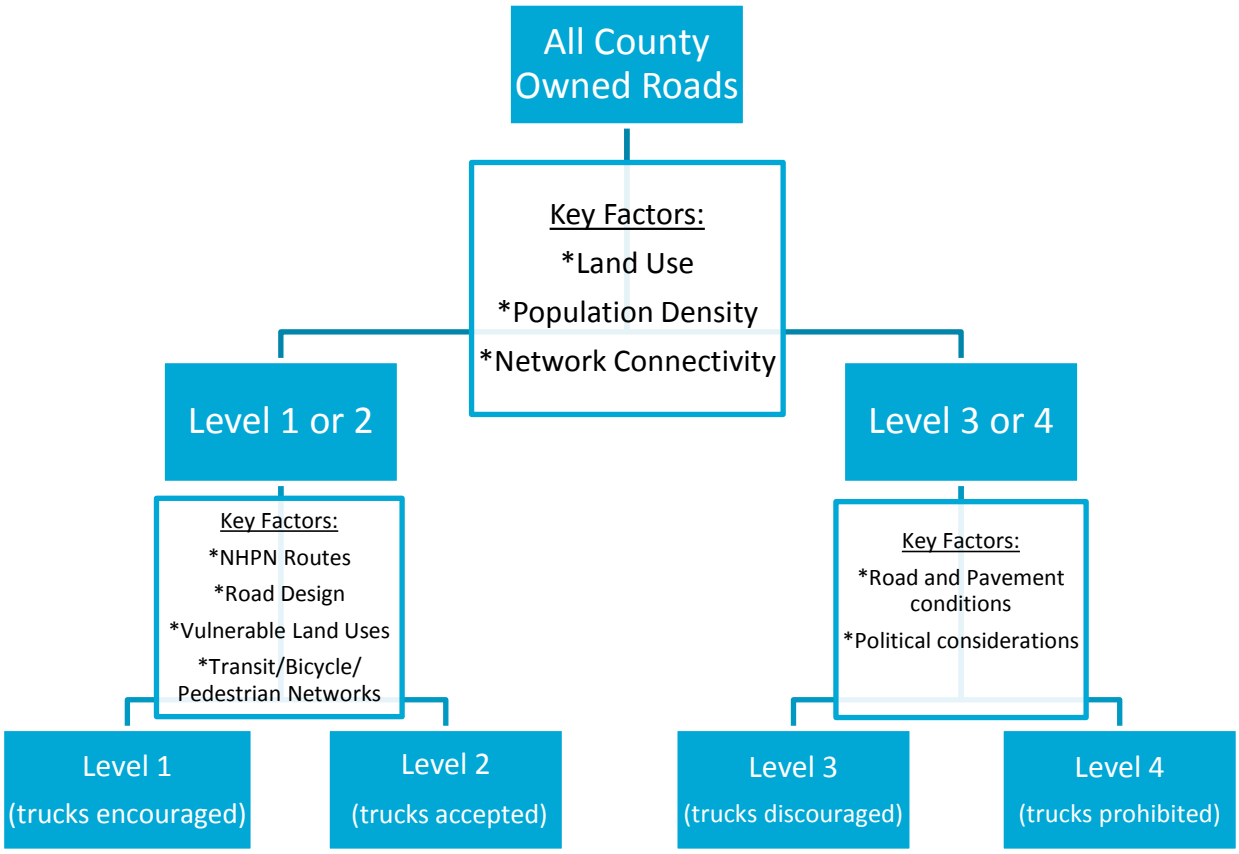


In order to determine route suitability and place roads on the Y-axis of the matrix, roads in the study region were split into four basic levels based on their intended use:

- **Level 1 Roads** – Routes on which both legal and oversize/overweight (OS/OW) trucks are encouraged to travel.
- **Level 2 Roads** – Routes on which truck travel is accepted.
- **Level 3 Roads** – Routes on which truck travel is not desired, but not restricted by law.
- **Level 4 Roads** – Routes on which truck travel is prohibited, either in its entirety or for all through traffic.

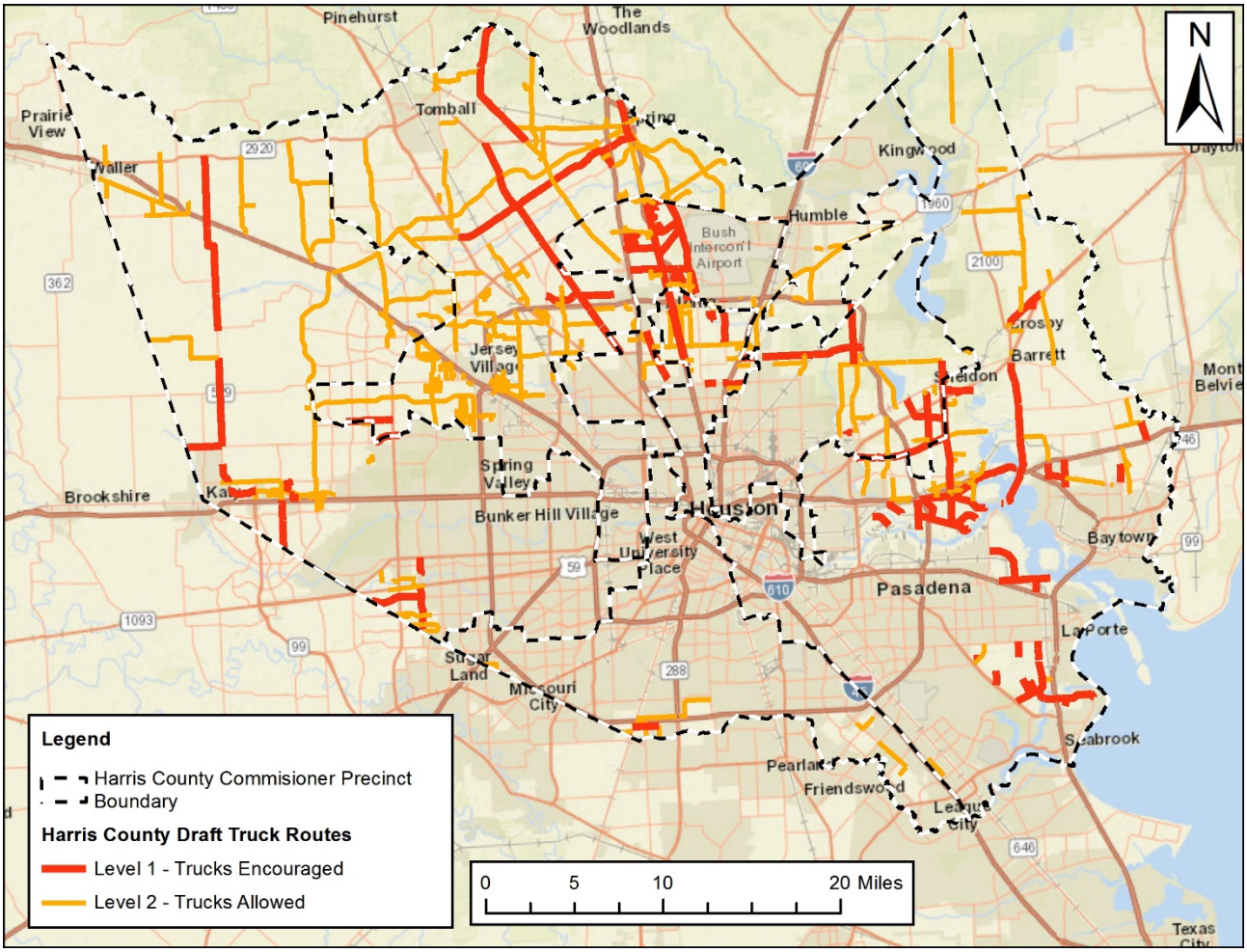
Route classification is arrived at using a dual-level choice tree model, shown in Figure ES.2.

Figure ES.2 Choice Tree for Designation of Harris County Truck Routes – Suitability



Applying this methodology to all of the roads owned by Harris County produced a Draft Truck Route Network consisting of Level 1 and Level 2 routes, shown in Figure ES.3 below. These routes were then analyzed based on their functionality in order place them on the matrix X-axis

Figure ES.3 Draft Harris County Truck Routes – Level 1 and 2



The Phase 1 report is intended to document the first step in the process of defining options for an investment strategy in developing a Truck Route Plan for Harris County. The benefits of a truck route plan include:

- General understanding of the freight demands of trucks on the county highways.
- Better understand the areas where cooperation with other entities (TxDOT, City of Houston, and other small cities) is needed, in order to develop continuity of truck routes for efficient means of goods movement.
- A tool to be used to support any application for special state or federal funding initiatives. The plan would document how the issuing of funds to Harris County would be used in a systematic approach to completing a county-wide truck route plan. Since the competition is so keen to capture their fair share of such funding initiatives, Harris County must have the proper justification for such funding. This report can be that justification tool.

In the next phase, it is expected projects will be defined by the County as worthy to be further analyzed to define needs improvements, including defining cost, limits, details, and schedule of

implementation. This report will provide Harris County with a road map for defining a strategic and systematic approach for the future and allow the County to remain proactive in addressing the challenges of growing freight and goods movement.

We want to acknowledge the efforts of County staff in their timely assistance to the Dannenbaum Engineering Team in completing this Phase 1 Study.

1.0 Introduction

The Phase I Study, provides a brief overview of the methodology employed to identify truck routes and infrastructure investment needs, examines the approaches used by peer cities and regions in developing their own truck routes, and lists key data sources analyzed. The work of the study team was managed by Dannenbaum Engineering, Inc., with support from its subcontractor Cambridge Systematics, Inc.

1.1 Purpose and Need

Harris County is a critical region for freight movement at the local, state, national, and international scale. The County is home to major intermodal terminals including the Port of Houston, George W. Bush Airport, as well as intermodal yards for three Class I railroads. The area is also home to numerous key industries that ship and receive goods from around the world. Although many of these companies rely on a multimodal supply chain to move goods, most trips begin and end with a truck.

Harris County initiated this study to identify appropriate routes for investment that would serve the needs of the business community and enhance the efficient and safe flow of truck traffic in the region. Because Harris County controls a limited number of routes in the County, this network must be integrated with and connect to TxDOT's Highway Freight Network, municipal truck route networks, and the regional truck route network developed for the Houston-Galveston Area Council (HGAC) in their 2012 Regional Goods Movement Study.[1]

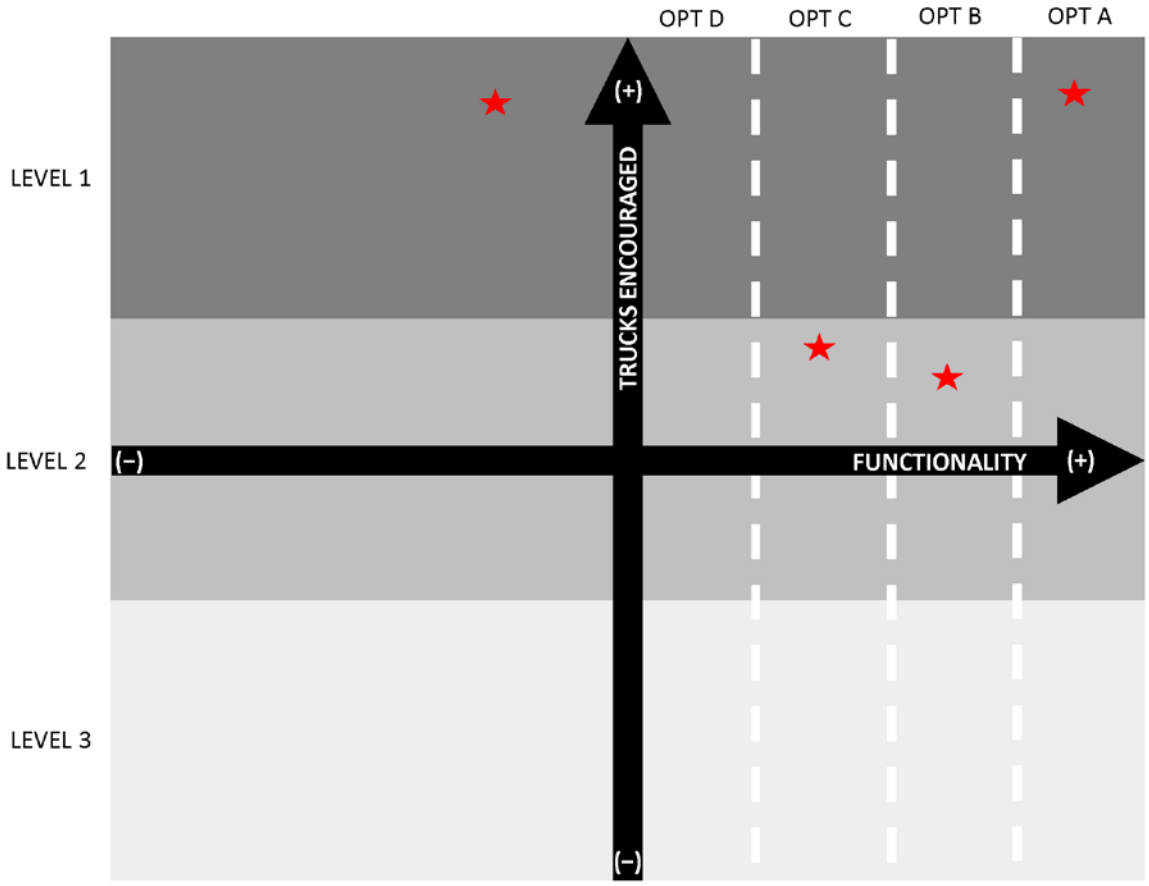
1.2 Methodology Overview

This Study used a two-step approach to produce a Draft Truck Route Network and identify potential infrastructure projects. The first step, explored in Section 2, identified route suitability through a planning-level analysis of County land use patterns, population, road characteristics, network connectivity, and truck origins and destinations, among other considerations. This approach identifies the need for a truck to use the road.

The second step, examined in Section 3, explored route functionality using an engineering-level analysis of factors including bridge and pavement condition and weight carrying capacity, lane width, etc. This approach identifies the ability of a truck to use the road in its current condition. This two-step analysis can be thought of as a matrix, shown in Figure 1.1 below, with the route suitability shown on the Y-axis and route functionality shown on the X-axis.

[1] http://www.h-gac.com/taq/regional%20goods%20movement/reports/default.aspx

Figure 1.1 Harris County Truck Route Matrix – Initial Concept



Both steps utilized a data driven approach that is repeatable throughout the County, and could be applied other roads in adjacent areas to produce an expanded regional network. Appendix C of this report provides example outcomes of the methodology as well as cost estimates. This study does not recommend specific infrastructure projects for advancement. It only identifies some example projects and provides the methodology needed to identify projects on the remaining routes in the County.

1.3 Literature Review

This Study included a literature review to gain an understanding both of the general issues around methodologies for truck route determination, as well as some of the specific situations and characteristics found in Harris County, Texas. The study team reviewed the available literature on the development of truck networks in the United States. This literature would be used to help focus stakeholder interviews and the data collection process.

The review included the 20 largest cities in the United States (by population) as well as any locations with a truck route methodology found during internet searches or where one of the study team members had previously conducted goods movement-related projects. After discussions arising from some of the initial stakeholder interviews, a further review was conducted of four additional East and Gulf Coast port cities: Norfolk, Charleston, Savannah, and New Orleans. A full list of literature review targets and associated material is found in Appendix A.

From the literature review, a number of key trends emerged. For cities or regions that had developed a comprehensive truck network, the majority focused on designation for truck enforcement, as opposed to balancing enforcement and investment needs. Two key trends from the various sources were identified.

One, for locations with an established network, the methodology focused on confirming the prior routes were still valid, re-examining prohibited routes to confirm the continued need for prohibition of trucks, and adding a limited number of additional routes to serve new needs. Ongoing investment was generally not considered as an explicit priority.

Two, for locations with no established routes, a fairly standard process was used to create a network. Most locations developed a multi-level network, though the classifications varied. For example, New York City uses through and local routes, Nashville created base and expanded routes.

1.4 Data Collection

Based on the literature review and the specific objectives of this Study, the project team crafted an approach to compile existing data about Harris County and its municipalities to support the development of a truck route classification methodology. The goal of the data compilation was to focus on the various factors which can be combined to develop initial rule sets for prioritization. Data sources generally fit into the following categories:

- **Highway Information** – Precinct road logs and existing truck routes.
- **Infrastructure Condition** – Traffic volume, number of lanes and road width, at-grade rail crossings, bridge and road weight limits.
- **Land Use** – Business locations, population density, intermodal facilities (Port of Houston, freight rail intermodal and classification yards), vulnerable land uses.
- **Other Road Users** – Transit and bicycle routes.
- **General Information** – Background and economic data from the State of Texas, Economic Alliance Port Region, and HGAC.

Appendix B contains a table with all data sources consulted during this Study.

In addition, multiple rounds of field visits have been conducted by study team members. In some cases, the Harris County project manager was able to participate in these visits. The visits enabled the team to better understand the connectivity issues in the region as well as to understand the viability of some types of data being requested. For example, lanes of traffic in and of itself cannot be considered a viable variable for truck route identification, as some of the higher truck volumes are found on two-lane highways feeding intermodal facilities.

1.5 Remainder of the Document

The rest of this document consists of:

- **Section 2: Route Suitability** – Describes the road classification process, a Draft Truck Route Network based on the suitability of each route to carry trucks, and the methodology used to create the network.

- **Section 3: Route Functionality** – Describes the methodology used to determine road condition and route functionality, or ability of a route to carry truck traffic and outreach performed to assist the study team in route selections.

- **Section 4: Results** – The Phase 1 report ends with a discussion of issues setting Harris County apart from other counties in Texas, as well as other parts of the United States, in addressing the growing needs of freight transfer by trucks. Also, a brief description is given about how the full Truck Route Matrix, defined in part in Sections 2 and 3, can be combined for Harris County Engineering and the four County precincts to use in selecting and prioritizing truck routes. The reader is introduced to Appendix C, which offers a cost model with some examples for establishing a program cost for each selected truck route within the Truck Route Plan. Finally, Section 4 offers a suggested course of action to take in order to better define the Truck Route Plan for Harris County.

2.0 Route Suitability

The first analysis examined route suitability, or how desirable truck traffic is on a given route. The methodology involved multiple steps as shown in the following sections, and provides the input for the Y-axis of the matrix in Figure 2.8.

2.1 Methodology Development

2.1.1 Overview

The following sections describe the multi-step process used to identify potential truck routes in Harris County. After reviewing the process used in other municipalities and regions in the literature review and discussions with the Harris County Engineering Department, the study team decided to employ a tiered approach to identifying routes. Using this methodology, all of the county-owned routes were divided into four levels based on their intended use:

- **Level 1 Roads** – Routes on which both legal and oversize/overweight (OS/OW) trucks are encouraged to travel. These routes should be obvious truck corridors or mixed-use routes critical to regional connectivity, a reasonable percentage of overdimensional trips should be able to fit on the routes, and the routes should be designed for higher than legal weights, such as full containers. Truck specific infrastructure projects will be considered for these routes.

- **Level 2 Roads** – Routes on which truck travel is accepted. These routes should act as connectors to local businesses or secondary corridors important for regional connectivity. They may accommodate other road users such as transit or bicycle routes, and are not designed primarily for trucks. Truck specific infrastructure projects will be considered in conjunction with other road needs.

- **Level 3 Roads** – Routes on which truck travel is not desired, but not restricted by law. These routes should provide for limited, local truck use. Operational and geometric barriers such as speed bumps, lower speed limits, or tight turn radii may be used to deter trucks (especially trucks without a local origin/destination) from using the corridor.

- **Level 4 Roads** – Routes on which truck travel is prohibited, either in its entirety or for all through traffic. Trucks may not use this route and restrictions will be backed by enforcement as appropriate.

This tiered system can be thought of as a dual-level choice tree model, shown in Figure 2.1.

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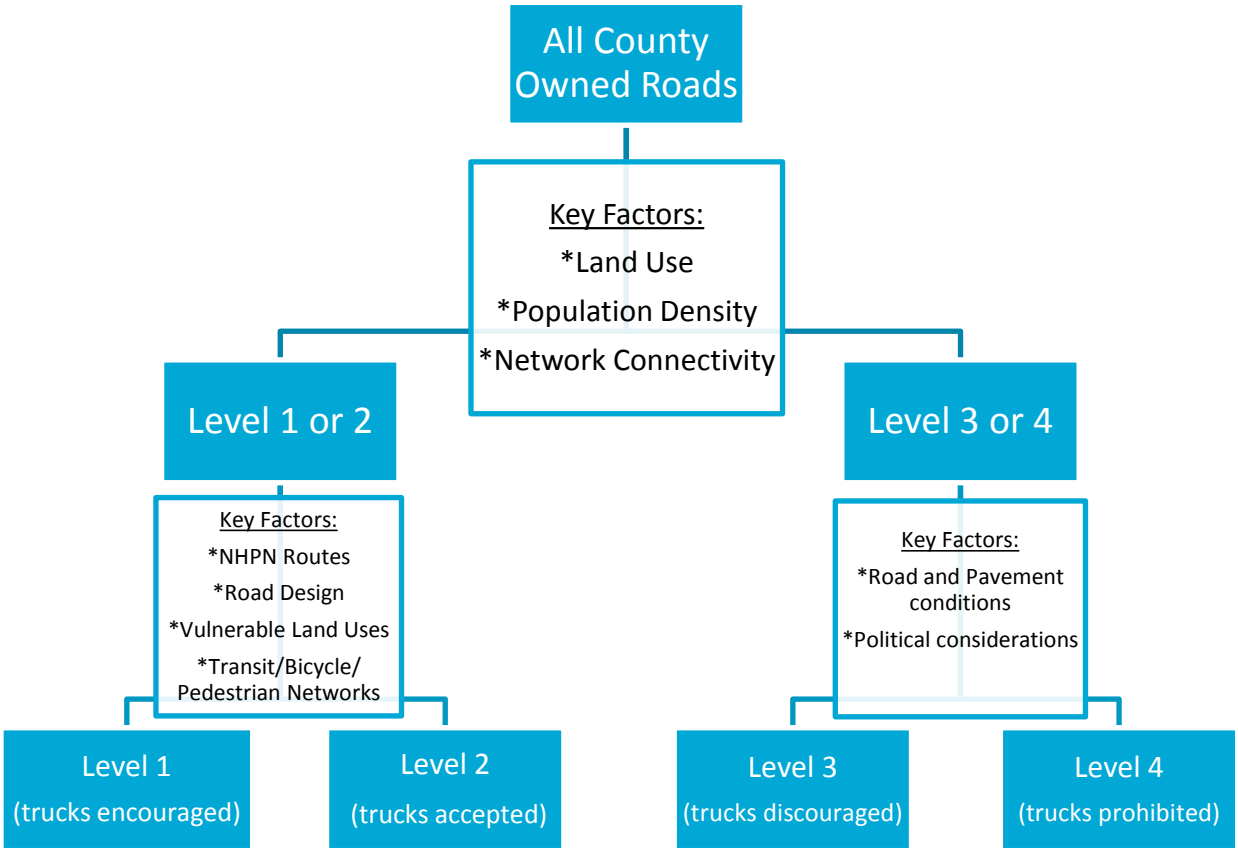
Figure 2.1 Choice Tree for Truck Route Suitability Analysis



- The first set of rules govern the choice as to whether truck traffic should be allowed or discouraged on a particular network segment.

- For allowed segments, the next choice is whether trucks should be encouraged to utilize the segment, including making proactive truck-related investments even when there are no passenger/transit/active transportation-related investments to be made.

- For discouraged segments, the next choice is whether to recommend legislative restrictions (or incorporate previous legislative decisions), or simply de-emphasize truck traffic and focus any investment strictly on passenger/transit/active transportation issues.

2.1.2 Decision 1: Developing Rules to Isolate Acceptable and Encouraged Routes

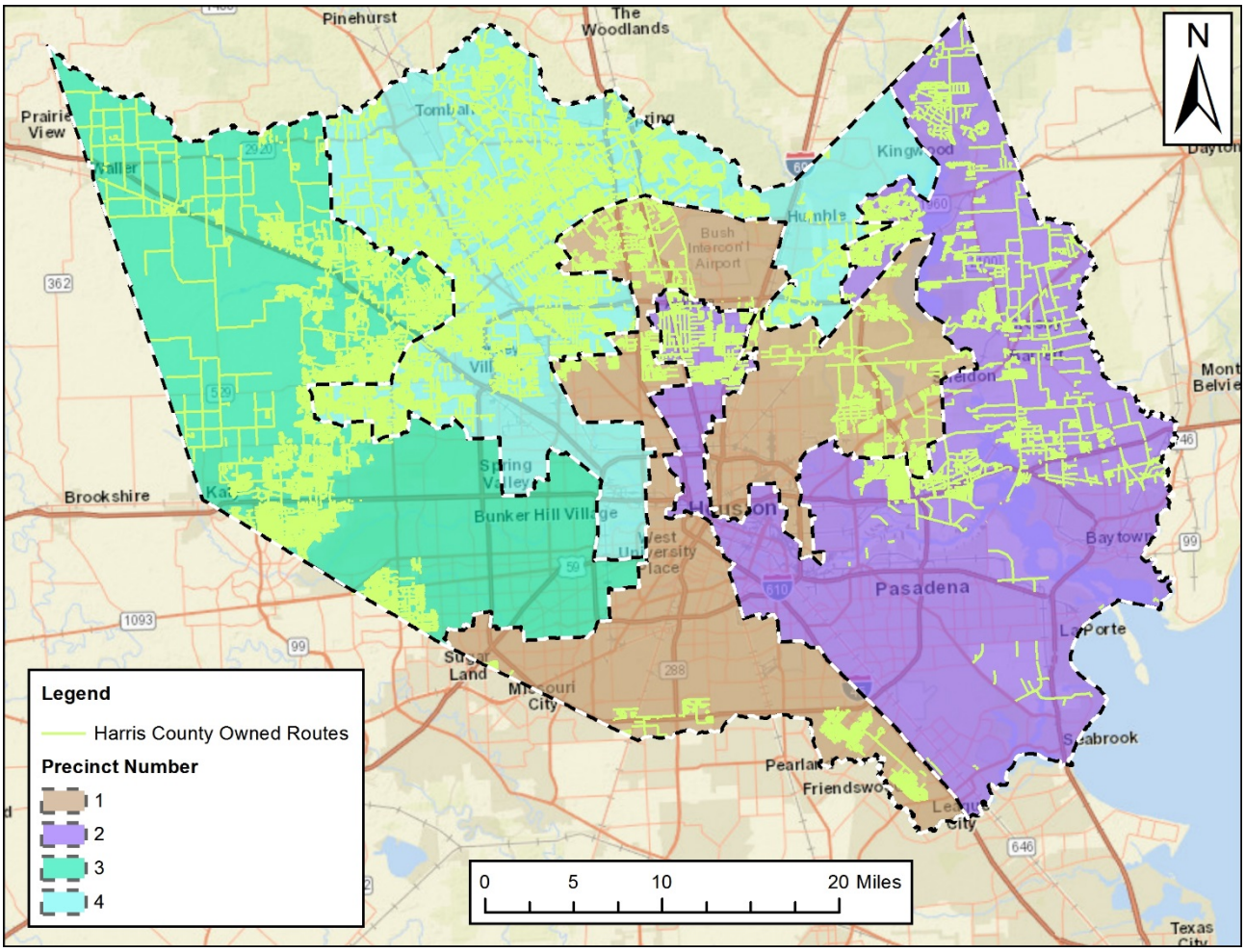
The first step was to identify potential Level 1 or 2 road segments. These routes are anticipated to carry the majority of truck traffic and will be designed and built to accommodate trucks, either expressly for Level 1 routes or as other projects allow for Level 2 routes. In selecting draft routes, three main goals were considered:

- Routes should create a logical and connected network.
- Routes should connect freight uses to each other and the larger regional network.
- Routes should avoid when possible areas with high population densities.

Step 1: Identify County Routes

In order to identify the County Route Network in Harris County, TxDOT's Roadway Inventory geographic information system (GIS) dataset was obtained. This database contains information on all road segments in the state including an identifier for county-owned roads. These segments were then mapped in a GIS tool. The resulting network is shown in Figure 2.2.

Figure 2.2 Harris County Owned Road Segments



Source: TxDOT, HGAC

Identifying a truck network for Harris County poses several interesting situations. There are no county routes within the City of Houston, and there are numerous locations where County ownership of a road ends and then continues after a short gap (typically between a pair of intersections). In addition, some of the major routes that trucks might use to reach regional destinations, such as Farm-to-Market (FM) routes, are not controlled by the County and thus cannot be selected to create a comprehensive network. This can lead to what appears to be a patchwork-like network as county routes reach a regional freight route and then end. This type of patchwork is fine as long as it is applied in concert with actions by other highway segment owners.

Step 2: Identify and Prioritize Previously-Defined "Regional Truck Network"

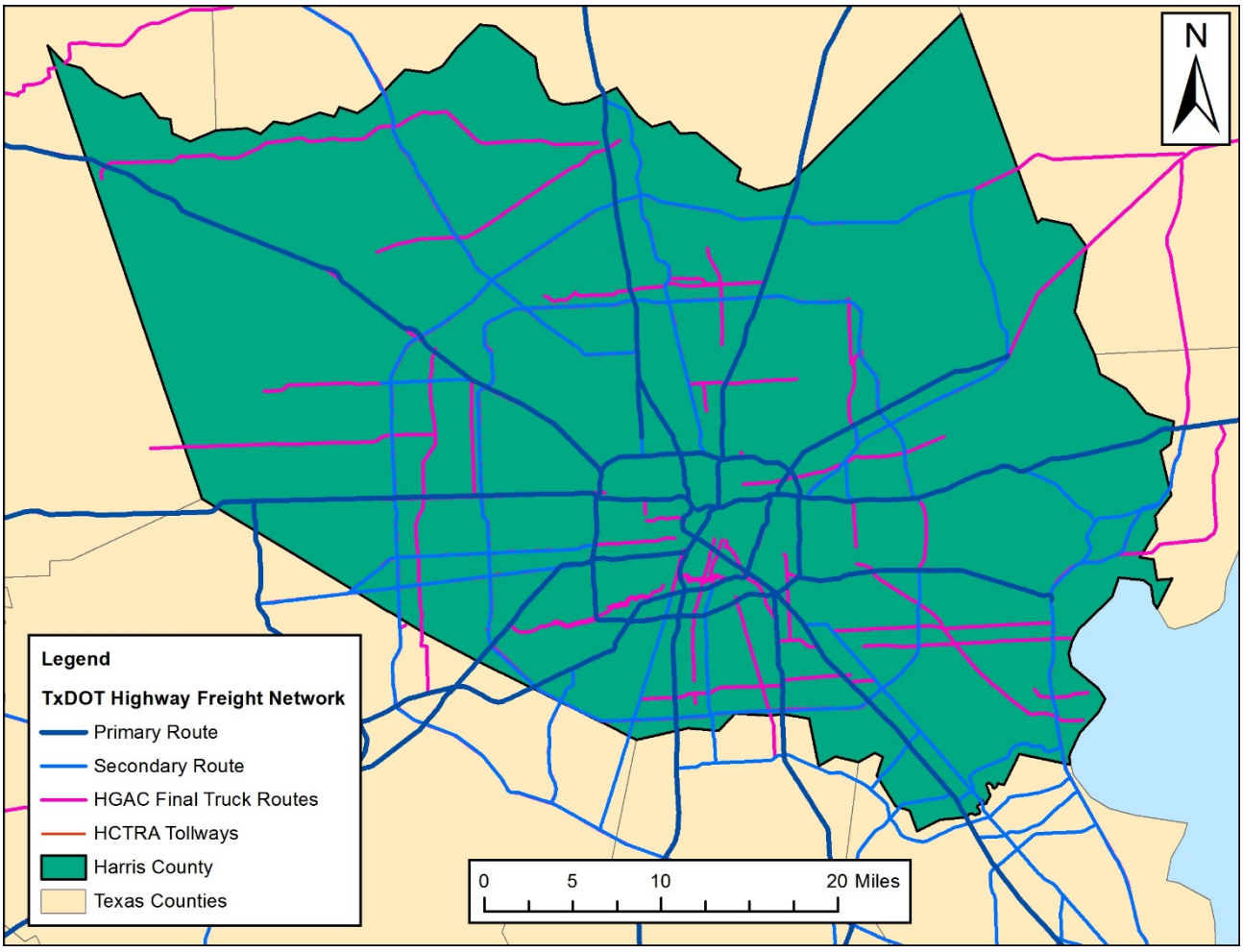
Since County-owned routes represent only a fraction of possible truck routes in the County, the next step was to add previously identified truck networks to the map, including:

- TxDOT's Freight Network (both Primary and Secondary)[2]
- Harris County Toll Road Authority Toll Roads
- Houston Galveston Area Council Recommended Truck Routes from the HGAC Regional Goods Movement Study[3]

Combining these three data sets created a list of roads that are the main freight arteries for the County. A small number of County roads are included in this list as part of the HGAC recommended truck routes – Wallisville Road in the Channelview area is one such example.

Figure 2.3 below shows the locations of these regionally significant freight routes.

Figure 2.3 Harris County Regionally Designated Truck Routes



Source: TxDOT, HCTRA, Cambridge Systematics

[2] http://www.txdot.gov/apps/statewide_mapping/StatewidePlanningMap.html

[3] http://www.h-gac.com/taq/Regional%20Goods%20Movement/default.aspx

Step 3: Identify Freight Generating/Attracting Land Uses

Multiple sources were compiled to identify potential freight generating or attracting land uses. The data sources below were spot checked with Google Earth and Google Maps to confirm data accuracy and identify vacant locations or areas of new construction that were not captured in the data sources. After collecting and mapping all of the data sources below, the Harris County Land Use data and the HGAC Freight Finder tool provided the most comprehensive coverage and best matched Google Maps and Google Earth imagery.

The following summarizes the various data elements used in Step 3.

- **Harris County Land Use**
  This land use layer was developed by Harris County and last updated in January 2014.[4] Land uses described as industrial, commercial, transportation/utilities, and agricultural were extracted and mapped separately. Although other land uses can generate truck trips, they do not do so at the same scale.

- **HGAC Freight Finder Tool**
  This tool was developed during the HGAC Regional Goods Movement Study. It identifies business locations in the HGAC region that are actively involved with the production, distribution, or consumption of freight on a daily basis and thus are responsible for the majority of truck trips that originate or terminate in the region.

- **U.S. Customs and Border Protection**
  U.S. Customs and Border Protection keeps a list of firms registered to handle bonded cargo. Although not all will generate significant truck volumes, they are another potential source of goods movement in the region due to the presence of the Port of Houston and George Bush Airport – both major international shipping hubs.

- **Bureau of Transportation Services Intermodal Terminal Facilities**
  The U.S. Bureau of Transportation Services maintains a list of intermodal terminal facilities which are locations where freight is transferred between two modes of transport.

- **U.S. Environmental Protection Agency Facility Registry Service**
  The U.S. Environmental Protection Agency Facility Registry Service (FRS) database contains sites that are required to register with the EPA. This analysis examined sites that file a Risk Management Plan which are reported by companies that handle, manufacture, use, or store flammable or toxic substances.

- **Powerplant, Petroleum Refinery, and Ethylene Crackers**
  Due to the heavy influence of the petroleum and energy industry in Harris County and the surrounding region, this analysis also obtained powerplant, petroleum refinery, and ethylene cracker location data from the U.S. Energy Information Administration (EIA).[5]

[4] http://data.ohouston.org/dataset/harris-county-land-use
[5] https://www.eia.gov/maps/layer_info-m.cfm

Step 4: Identify Dense Population Areas

The final goal for the Draft Truck Route Network was to attempt to avoid areas with a high population density. Roads that run through heavily populated residential areas are not ideal truck routes even though some truck access may be needed in order to reach local origins and destinations. This is not an absolute rule, as sometimes there will be no choice but to go through a high-population neighborhood. But as an initial screening rule, it is an appropriate choice.

Truck routes are defined on a road-by-road basis, often involving a choice between two adjacent routes in close proximity to each other. This need for precision combined with land use data available at a granular level necessitated the use of Census Block level data from the U.S. Census Bureau. The most recent data at this scale is from 2010. GIS was used to determine the area of each block in order to calculate population density. The average population density of Harris County is approximately 2,402 persons per square mile.[6]

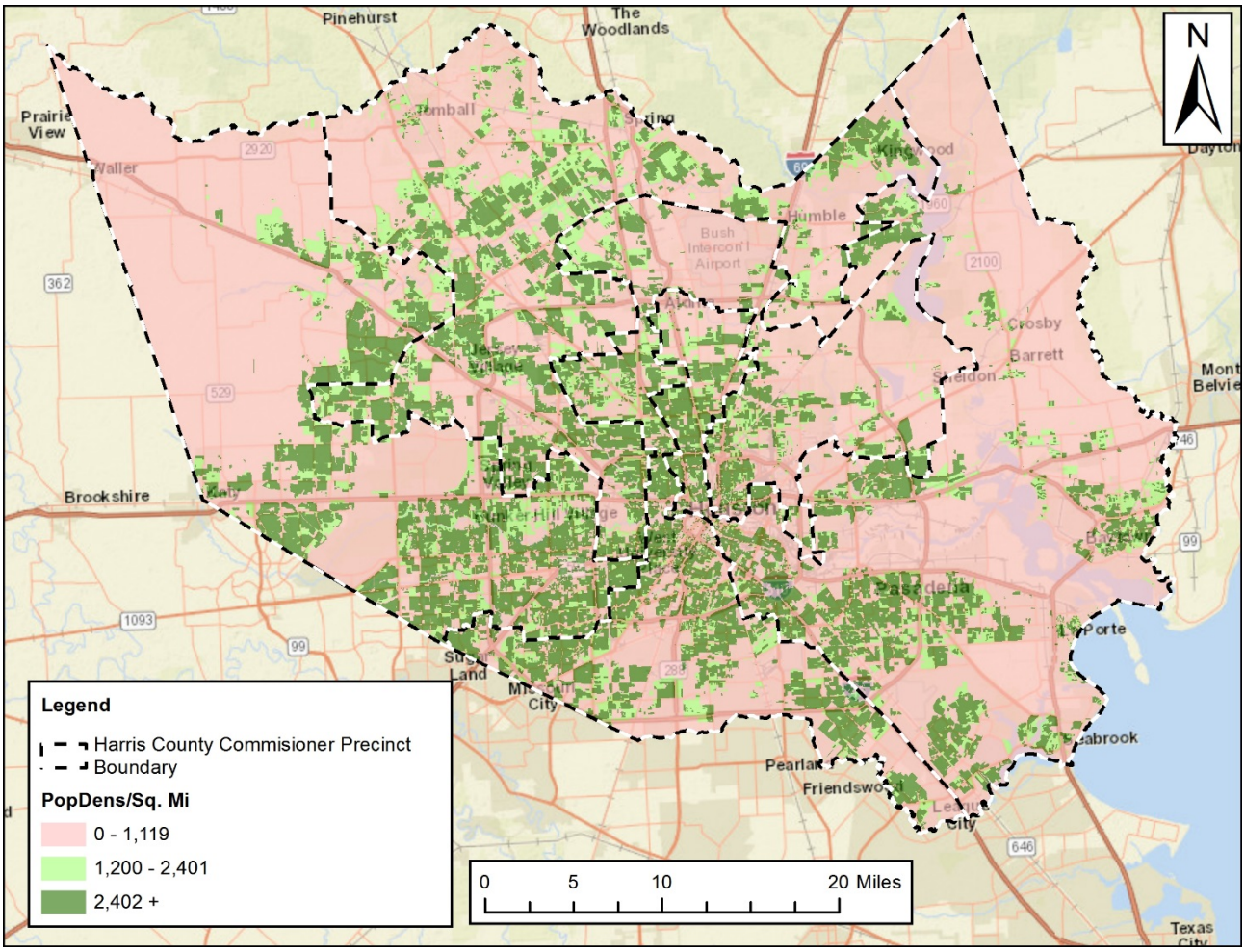
The analysis split the blocks into three categories:

- **Low** – those with less than 1,200 persons/sq. mile (approximately half of the average density).
- **Medium** – those between 1,200 and 2,402 people per square mile
- **High** – those with more than 2,402 persons per square mile.

Population density for the County is shown in Figure 2.4 below.

[6] U.S. Census Quickfacts

Figure 2.4 Harris County Population Density



Source: 2010 U.S. Census, TxDOT

Areas with high population densities are mainly located within the City of Houston (where Harris County does not control any roads), southwest of the City along IH-69, near Pasadena, and northwest of Houston along SH 6 and FM 1960.

2.1.3 Decision 2: Differentiate between Level 1 and Level 2 Routes

The second step in the identification process was to distinguish between Level 1 routes where truck traffic should be encouraged through geometric and operational enhancements, and Level 2 routes where truck traffic is accepted and improvements that benefit truck movements are implemented in combination with other road improvements. A number of data sets were used to help with the differentiation between these routes:

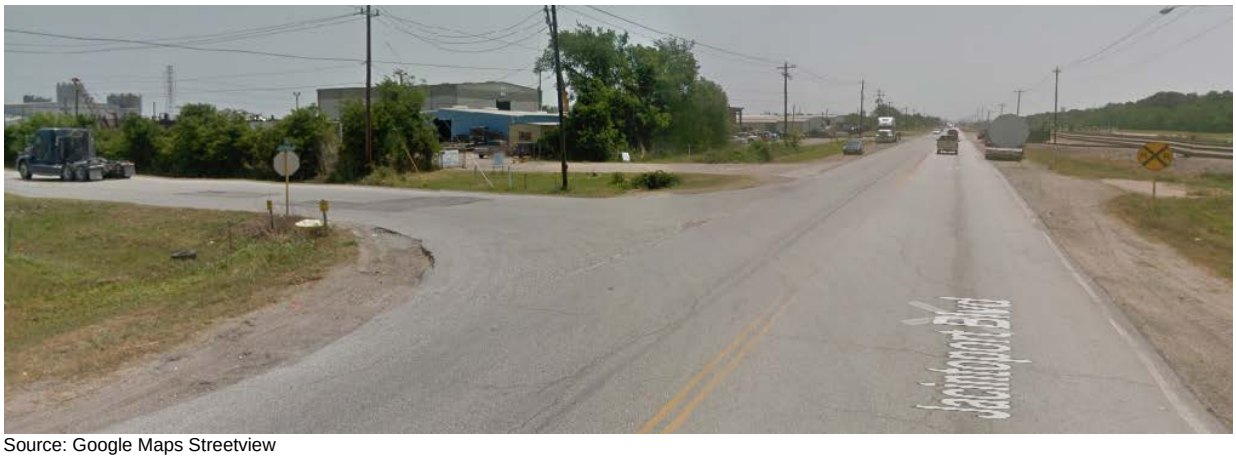
- **National Highway Planning Network Routes**
  The National Highway Planning Network (NHPN) contains routes that are part of the National Highway System, the Interstate System, the Strategic Highway Network (STRAHNET), National Highway System Intermodal Connectors, and all roads functionally classified as principal

arterials or rural minor arterials. [7] Any draft route on the NHPN was automatically classified as a Level 1 route. In the Channelview Study Region this includes Jacintoport Blvd., Penn City Rd., and Sheldon Rd. south of IH-10;

- **Traffic Volume**
  Ideally, both passenger and truck volume would be utilized. Due to a lack of accurate data for truck volume, total traffic volume was used as a reference to understand which routes were the key arterials through the region for all traffic types. This data quality issue is discussed in more detail in Section 3.

- **Number of Lanes and Road Configuration**
  County-owned roads in the area varied between two and four lanes. There are also some areas with a substantial median between the two directions of travel, and between the road and surrounding land uses. While informative, it was determined that using the number of lanes as a criteria would produce counterintuitive results. For example, many of the most important roads for trucks – such as those that access port facilities or industrial areas such as Jacintoport Blvd. in Precinct 2 shown in Figure 2.5 below – are two lane roads while some of the four lane roads with divided medians are in areas with a high population density.

Figure 2.5 Jacintoport Blvd. at Appelt Dr. - Looking East



Source: Google Maps Streetview

- **Vulnerable Land Uses**
  Vulnerable land uses and planning-level impediments such as schools, hospitals, at-grade rail crossings, transit routes, and bicycle routes were mapped. Although no specific rule was developed (i.e. more than 2 at-grade crossings means the route must be a Level 2), the presence of these facilities was considered in the overall scheme. These impediments were also considered in the initial selection of draft Level 1 and 2 routes when they were easily recognizable. For example, if two parallel routes both provided access to freight land uses and one passed by a large school complex, the other route was selected as a draft Level 1 or 2 route.

[7] http://www.fhwa.dot.gov/planning/processes/tools/nhpn/

2.1.4 Decision 3: Isolating Level 4 Routes

One element missing from the current draft network are Level 4 routes. It is anticipated that in addition to engineering concerns, identifying Level 4 routes will be a politically sensitive process—unless an issue is raised on a draft Level 1 or Level 2 route, the designation of Level 4 routes often involve factors beyond the analytical nature of the Study. For purposes of this Study, any route not specifically identified as a Level 1 or Level 2 route was designated as Level 3. Identifying Level 4 routes will require guidance from stakeholders and is beyond the scope of this Study.

2.2 Outreach

The methodology described above to classify routes based on suitability for truck traffic was initially tested on the roads in the Channelview region of Harris County and then presented to stakeholders to solicit feedback and identify any potential gaps in the process. Feedback from a presentation on July 28, 2016 confirmed the soundness of the approach which was then applied to the entire County.

2.3 Post Processing and Additional Data

To address one of the data limitations discovered during the initial review process, strategic traffic counts were conducted at 19 intersections in Harris County. This provided accurate truck traffic data that was used to confirm draft route level designations, especially at intersections where it was unclear which routes trucks use to reach the regional truck route network. This data was used to find routes that, based on land use patterns and connectivity, were initially included in the draft Level 1 and 2 route network, but actual truck activity showed that the route carried limited amounts of truck traffic and could be left as a Level 3 routes – routes where truck traffic (especially through traffic) is discouraged.

For example, truck count data at the Sheldon Road, Ashland Boulevard, and Bear Bayou Rd. in the Channelview region showed that Ashland Avenue is not heavily utilized by trucks. This route was initially identified as a Level 2 routes based on connectivity and local freight needs, but the lack of truck traffic caused the road to change from a Level 2 to a Level 3 route. This data only became available after the initial selection of truck routes, and was employed as a check on specific route designations instead of as part of the initial decision process.

2.4 Results

The above methodology produced a Draft Harris County Truck Route Network shown in Figure 2.6. Figure 2.7 shows the Draft network in addition to the other regional truck networks described in Section 2.1.2 in order to illustrate the role Harris County roads play in creating a complete, connected truck network.

Figure 2.6 Draft Harris County Truck Route Network

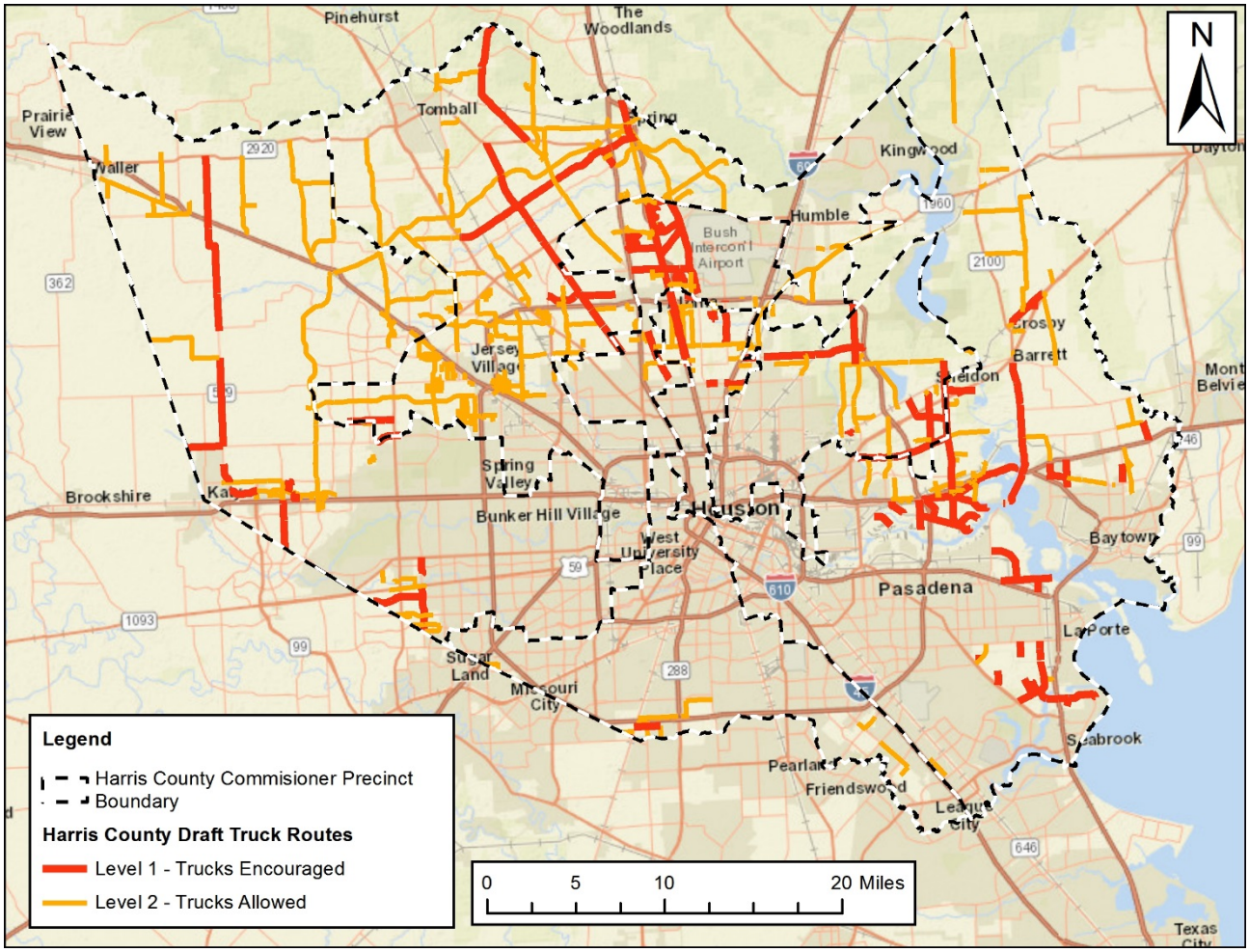
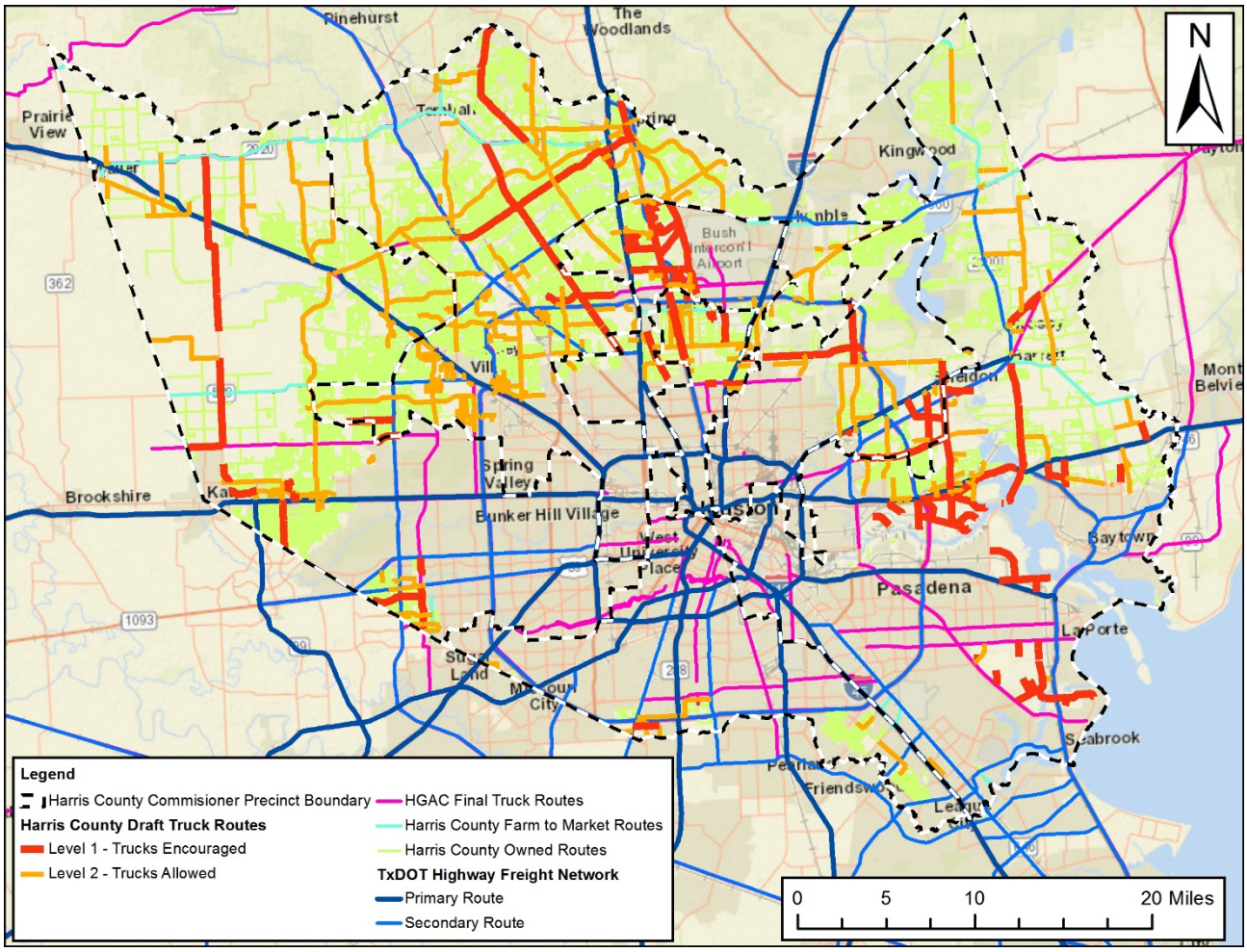
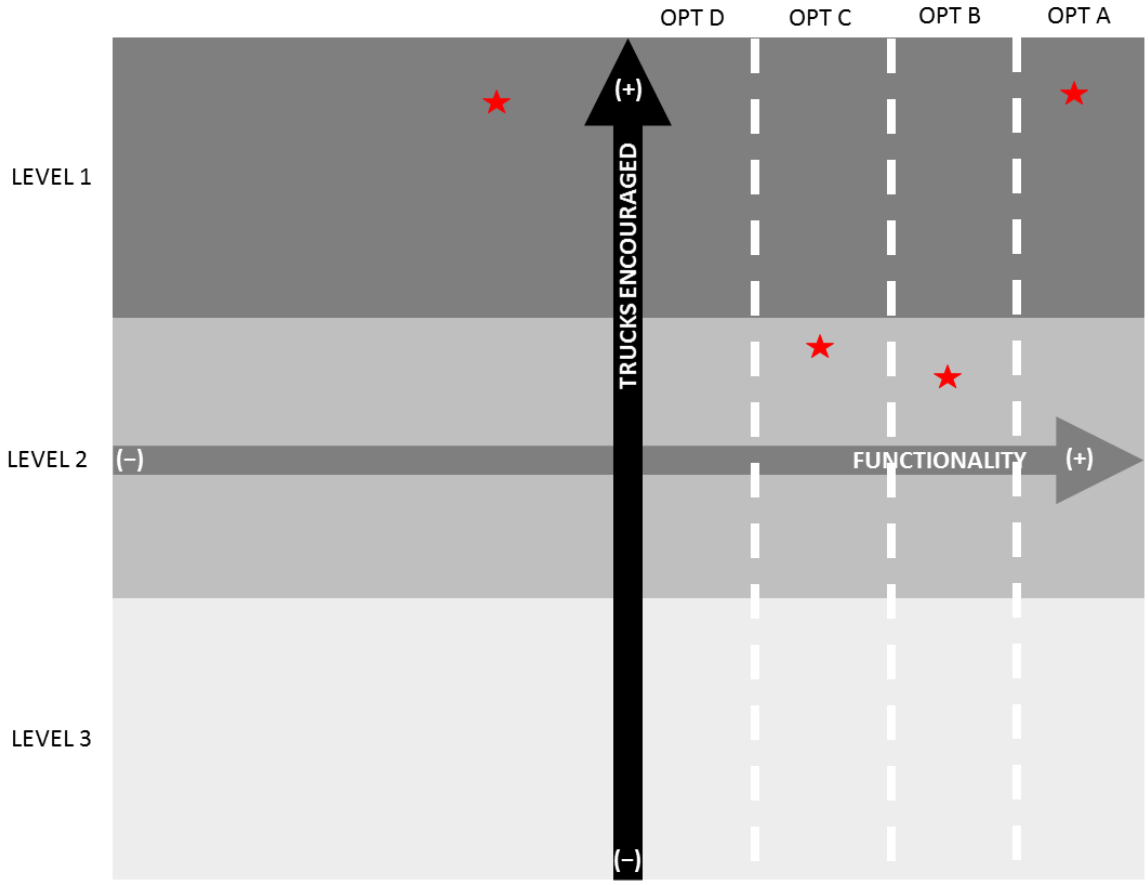


Figure 2.7 Draft Harris County Truck Route Network and Regional Truck Networks



This method of classification provides the vertical axis input needed for the Truck Route Matrix, as shown in Figure 2.8. Each road in the County can be placed along the vertical axis based on the above analysis, showing the suitability of the road for carrying truck traffic. As shown in the matrix, the Truck Route Levels developed during this analysis are not distinct. In reality, some Level 1 routes are better Level 1 routes than others and some Level 2 routes are close to being Level 3 routes. Roads will be placed on this continuum rather than in specific tier brackets, allowing for a more nuanced view of the County's network.

Figure 2.8 Harris County Truck Route Matrix – Suitability (Y-Axis Only)



3.0 Route Functionality

The second analysis examined route functionality, or the ability of a route to accommodate truck traffic. This analysis focused on the Draft Level 1 and Level 2 Truck Routes identified in Section 2. This process provides the input for the X-axis of the matrix shown in Figure 3.1 and enhanced in the prior section.

3.1 Methodology

Route functionality similarly depended on a classification of routes into multiple levels. The first step in this process was defining the characteristics of a route. The following screening parameters were used:

3.1.1 Level 1 Route

- Route is in a commercial and/or industrial area resulting in heavy truck traffic.
- Route must have direct access to a major interstate Highway or is directly connected to a road that does.
- Route must have appropriate main lanes and shoulder width or the capacity to be widened.

The third criteria required a further level of detail in order to define what an appropriate main lanes and shoulder width should be. Roads that met the following standards were considered appropriate:

- Two or more lanes in each direction – 11’ minimum lane width.
- Single lane in each direction – 12’ minimum lane width with 10’ shoulder.
- If one of the two above criteria are not met, the route should have sufficient ROW to increase the width of the road, or there should be no major constraints to obtaining additional ROW. Potential constrains include the presence of schools, churches, parks, and residential communities.

3.1.2 Level 2 Route

- Route is in a Commercial/Residential area resulting in moderate truck traffic.
- Route must be in close proximity to a road that has direct access to a major Interstate Highway.
- Route must have sufficient main lanes and shoulder width or the capacity to be widened.

  As with the Level 1 routes, the third criteria required a further level of detail in order to define what an appropriate main lanes and shoulder width should be. Roads that met the following standards were considered appropriate:

- Two or more lanes in each direction – 11’ minimum lane width.
- Single lane in each direction – 12’ minimum lane width with 10’ shoulder.
- If one of the two above criteria are not met, the route should have sufficient ROW to increase the width of the road, or there should be no major constraints to obtaining additional ROW. Potential constrains include the presence of schools, churches, parks, and residential communities.

3.1.3 Screening

Based on the above, the next step was to conduct a screening process of routes identified in the Route Suitability analysis as Truck Routes. First, the data was converted into spreadsheet form which included important characteristics including:

- Route ID's
- Street names
- Segment length as measured between cross streets
- Precinct

Each potential route was evaluated based on the criteria listed above. To determine if the route is mainly in a commercial/industrial area, the study team identified the percent of land along the route that fit one of the land use categories as compared to all parcels along the route. Road connectivity to a major highway was analyzed using Google Earth and Google Maps. Finally, the TxDOT RHINO GIS data used as the basis for the study provided lane and shoulder width information.

If the route met all the criteria, then it was designated as a Level 1 or Level 2 truck route. If a route did not meet the criteria, it was flagged for further investigation.

3.1.4 Bridges

A three step method was used to initially screen bridges for likely candidates for rehabilitation or replacement using Bridge Sufficiency Ratings and Status of Functionally Obsolete (FO) or Structurally Deficient (SD) data from the National Bridge Inventory (NBI). The Sufficiency Rating of a bridge is essentially an overall rating of the bridge's ability to serve the public. Fields that influence the Sufficiency Rating include the structural appraisal, functionality, and essentiality to the public.

Sufficiency Ratings are calculated on a 0 (low) to 100 (high) scale. A low rating may indicate structural defects, narrow lanes, low vertical or horizontal clearances, and other potential issues. A bridge is identified as FO when it is no longer adequate for use for reasons that include insufficient lanes for traffic, lack of shoulders, or insufficient over or underclearances.

A bridge is identified as SD when there are one or more structural defects that require attention. The bridge deck, superstructure, substructure, or channel protection ratings provide additional information regarding the nature and severity of the structural defects.

First, bridges with a Sufficiency Rating exceeding 80 were eliminated since this is an indication that the bridge is in good structural condition and is adequate for current roadway demands.

Second, bridges with a Sufficiency Rating less than 50 are candidate for replacement. Only one bridge analyzed was in this category due to its SD status.

Third, bridges with a Sufficiency Rating between 50 to 80 and a status of FO or SD are eligible for rehabilitation or replacement.

In general, bridges that have insufficient deck width are good candidates for widening, and bridges that have insufficient underclearances are good candidates for replacement due to the high expense of fixing this type of defect.

3.2 Outreach

An important aspect of the Study was to execute an outreach program. The program provided the study team with valuable review and feedback from critical stakeholders at key steps in the development of the Study. At the 25%, 50% and 90% completion stages, stakeholder meetings were held with:

- Harris County Engineering
- Harris County Judge and four Precincts
- Houston Galveston Area Council (HGAC)
- Economic Alliance Port Region

The result of this outreach was:

- Consensus with study approach and methodologies used.
- Approval of Level 1 and 2 highway options by each of the four precincts, including route options added by precincts to supplement the initial work of the study team.

3.3 Results

The Functionality analysis of route options were completed using a step process, consisting of:

- Compare suitable route choices on the basis of functionality characteristics (proximity to major freight corridors, pavement widths and condition, bridge cross section and condition, available right of way, and other conditions), in order to confirm suitability of the routes.
- Solicit input and verification from Harris County Engineering, as well as the four precincts, of the choices by groupings (Level 1 through 4).
- Incorporate the input from critical stakeholders, and modify the route options by further analysis on the basis of functionality. In some cases, the precincts added, modified lengths, or even changed grouping designations.
- Complete and roll-out new Level 1 and Level 2 route options. The results included updated GIS based mapping as well as updated spreadsheet comparisons.

GIS mapping identified 137 bridges located on the potential Level 1 truck routes. National Bridge Inventory (NBI) data for each of these bridges was obtained from the Federal Highway Administration and reviewed against current criteria. It is important to note that this review only considers current roadway functional classifications. Additional improvements needed to achieve the preferred truck route cross section are not included and will be developed in collaboration with HGAC. Therefore, this analysis represents a lower bound of improvements needed to meet current demands and maintenance.

Following is a summary of the results from the initial bridge screening process.

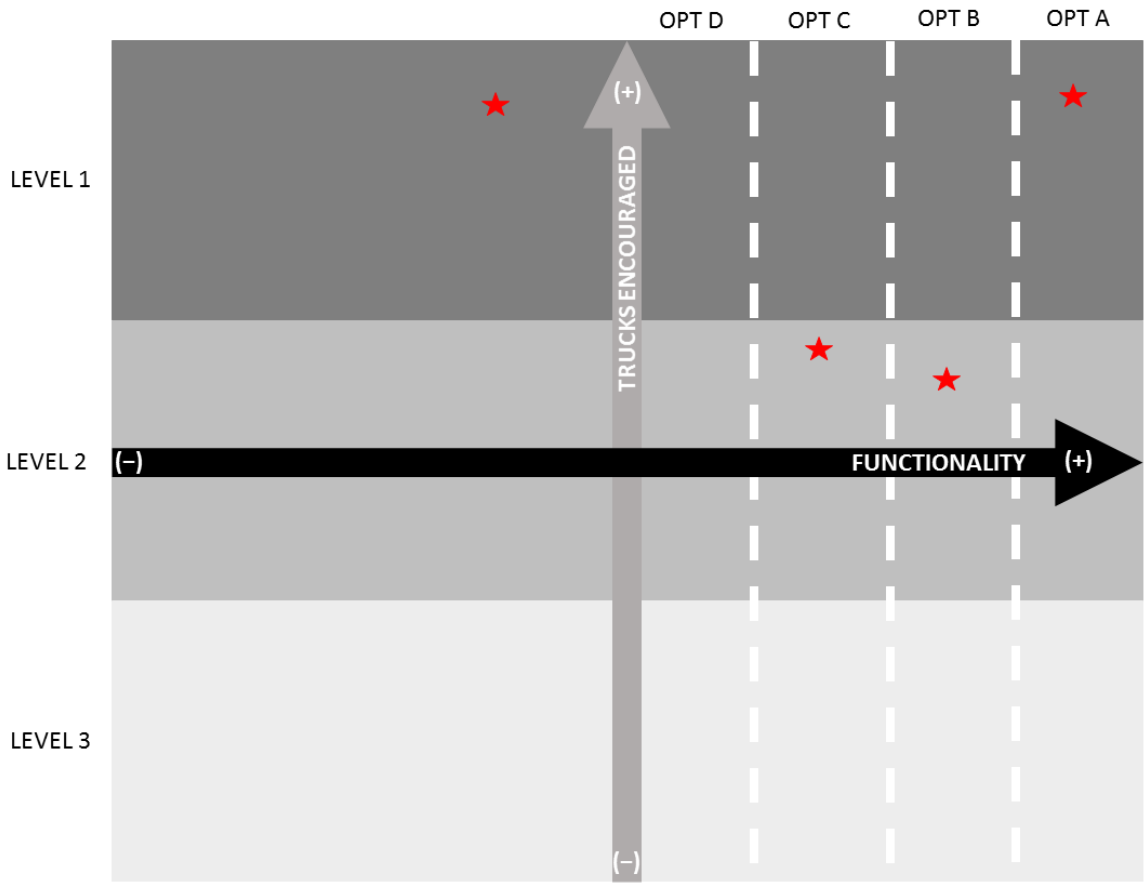
Table 3.1 Bridge Inventory Screening Summary

Sufficiency Rating	Status	Corrective Action	No. of Bridges	Percent of Total
80-100	None	None	68	49.6%
50-80	FO (Roadway Width)	Widen	60	43.8%
50-80	FO (Underclearance)	Replace	8	5.9%
0-50	SD	Replace	1	0.7%
Total			137	100%

The next step to evaluating bridges along potential Level 1 truck routes would be to individually assess each bridge to accommodate the preferred roadway cross sections. It is likely that this evaluation will result in additional bridges being added to the corrective action list.

As part of this additional evaluation, estimated construction costs can be calculated with higher confidence since the amount of widening can be quantified. Average costs for new bridge construction for conventional concrete structure types generally range from $60 to $150 per square foot, and the cost of widening bridges is slightly higher on a per square foot basis. Final determinations of whether to rehabilitate or replace bridges will be based on lowest life-cycle costs for the County.

Figure 3.1 Harris County Truck Route Matrix – Functionality (X-Axis Only)



Functionality is an absolute measure and not relative to each Level route type. This means that there may be some Level 1 routes that have a medium or even low functionality score based on the matrix, but this does not mean that they are unable to handle current traffic needs.

The following set of Figures show the final Level 1 and 2 truck routes by County and then by precinct.

Figure 3.2 Harris County Truck Routes

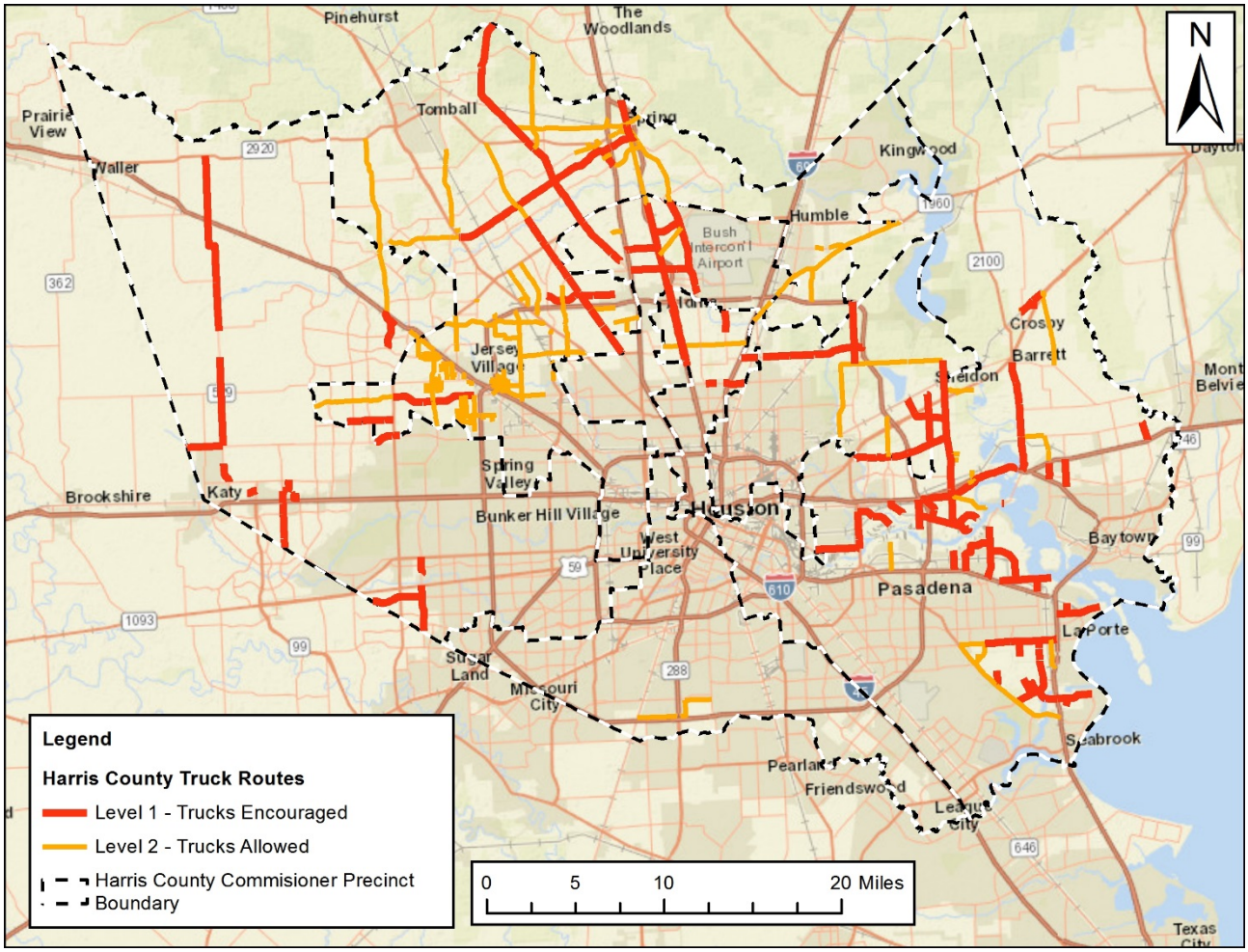


Figure 3.3 Precinct 1 – Final Truck Routes Level 1 and 2

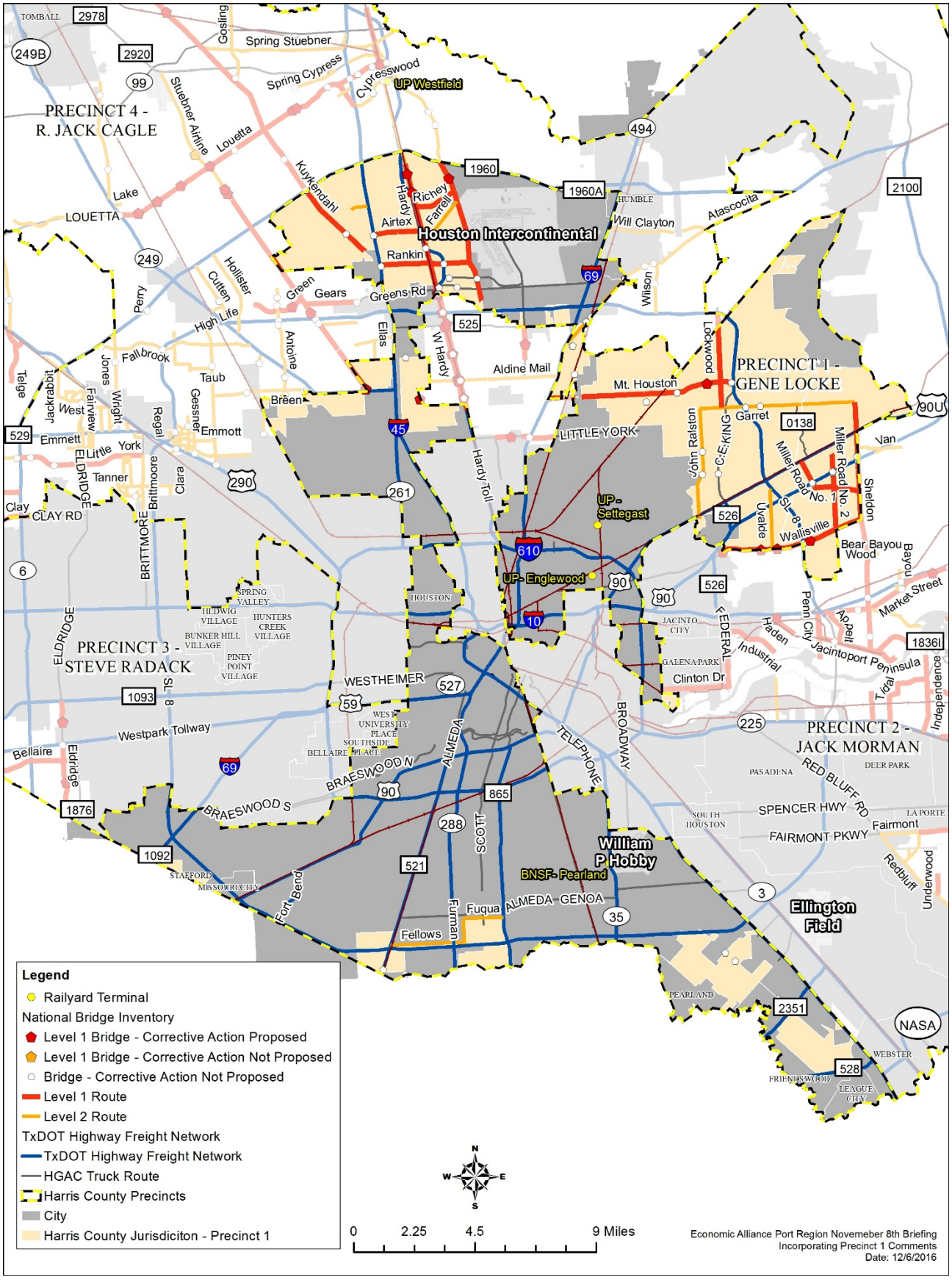


Figure 3.4 Precinct 2 – Final Truck Routes Level 1 and 2

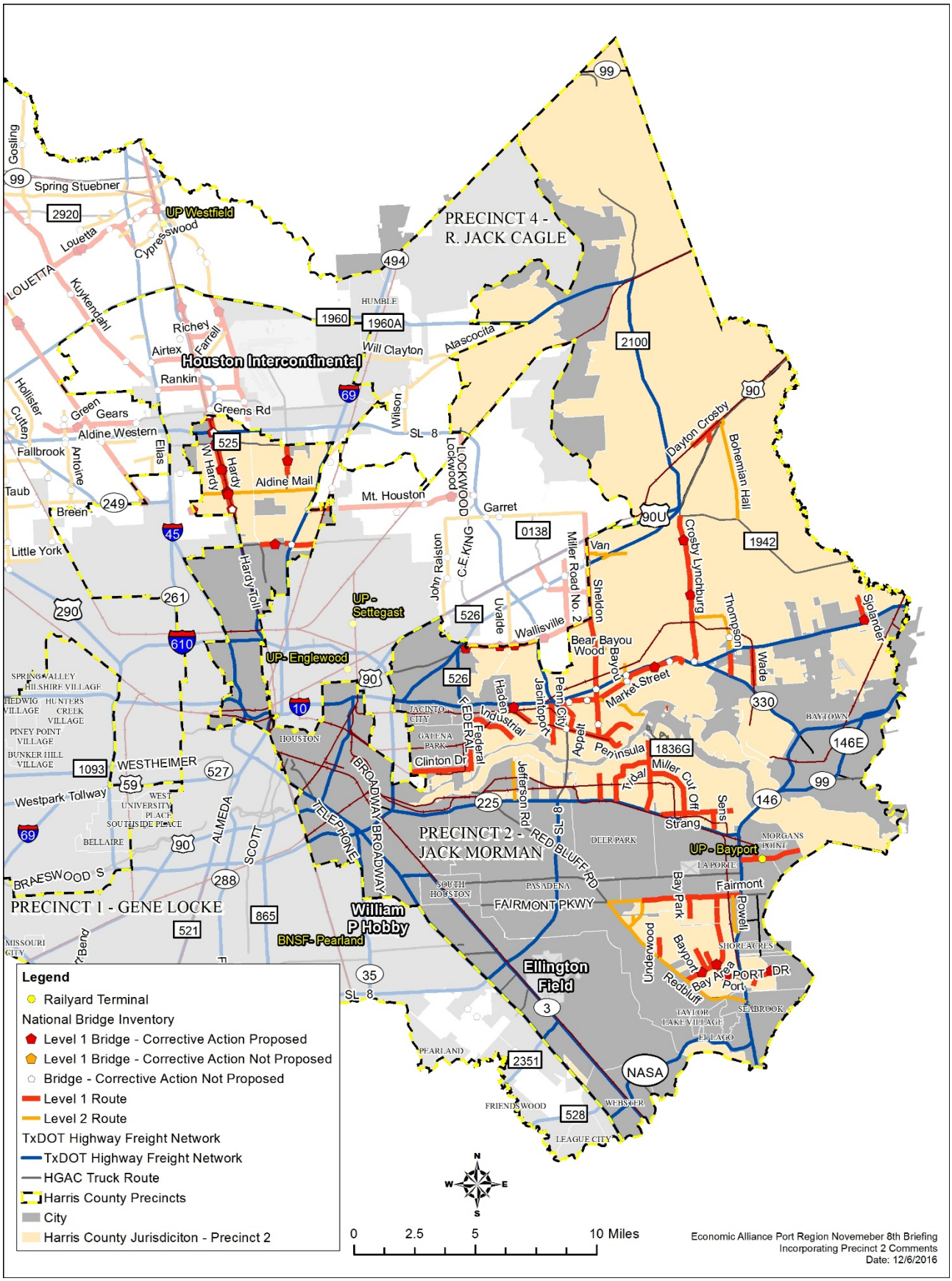


Figure 3.5 Precinct 3 – Final Truck Routes Level 1 and 2

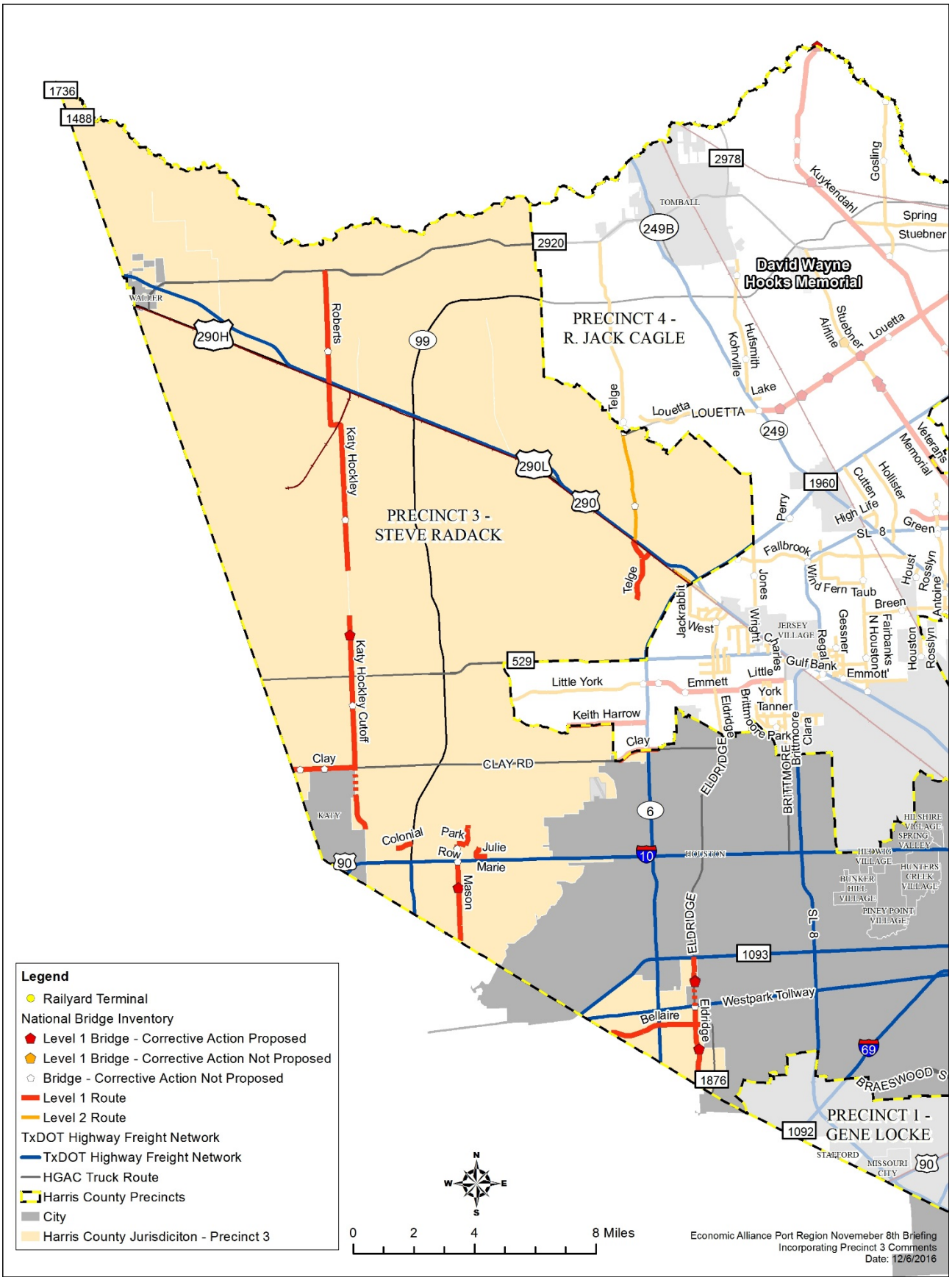
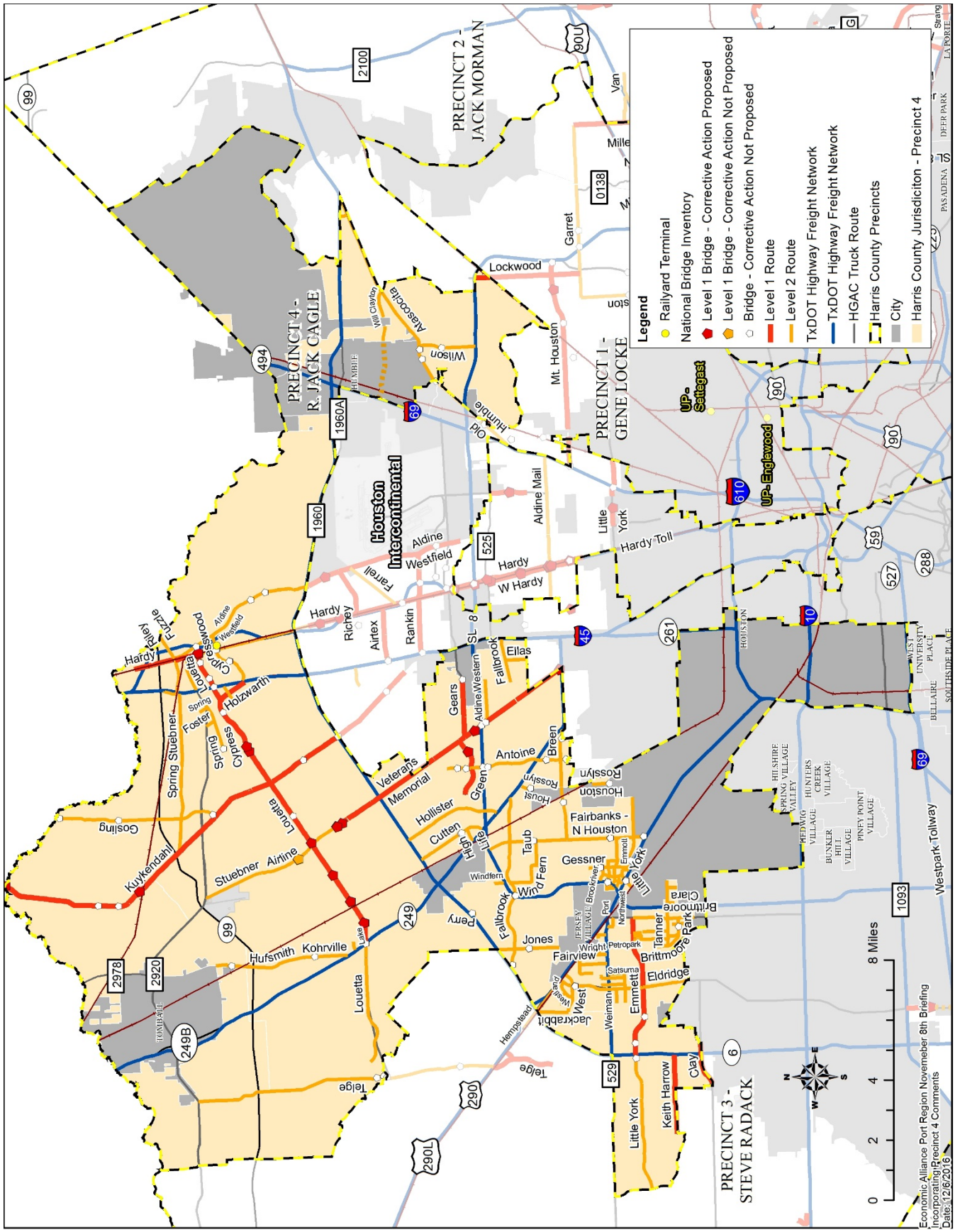


Figure 3.6 Precinct 4 – Final Truck Routes Level 1 and 2



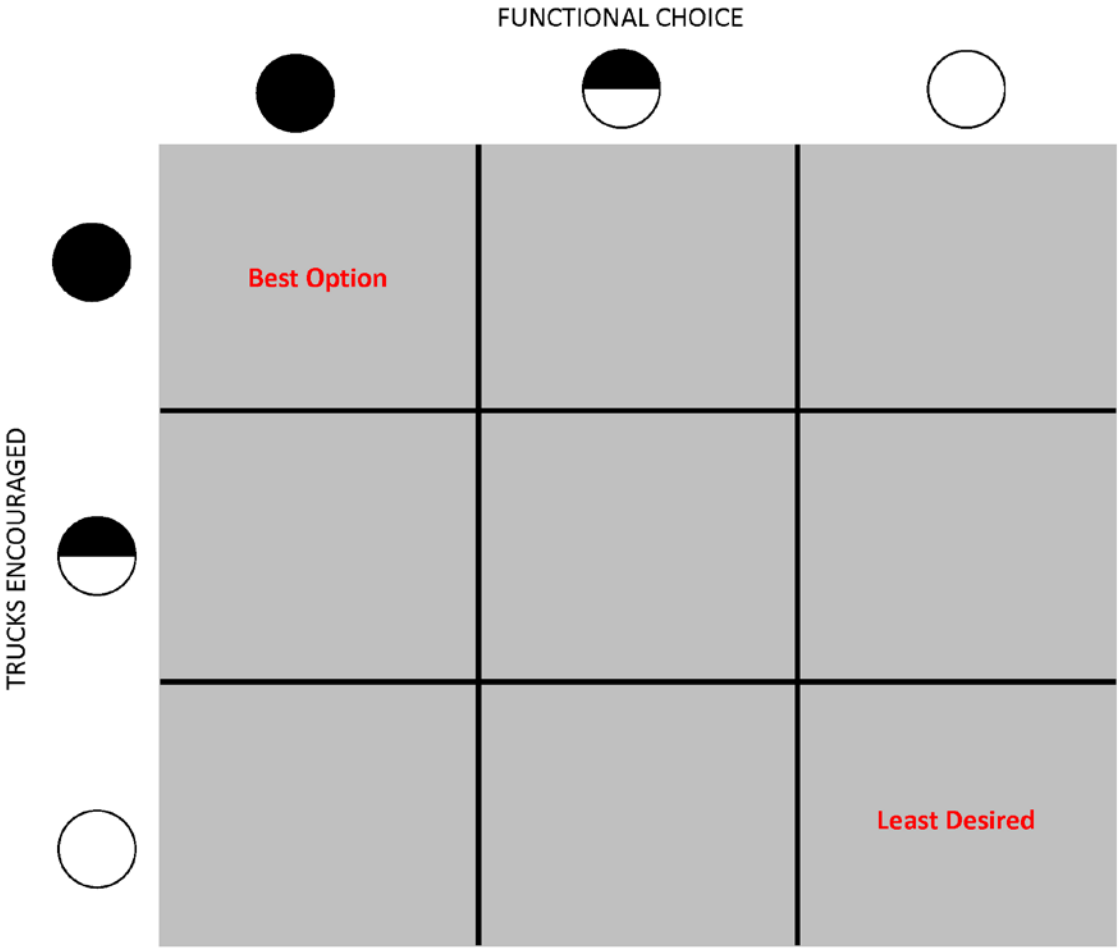
4.0 Moving Forward

Although it is beyond the scope of this Phase I Study to apply the Truck Matrix concept to every Harris County road, the below section provides examples from each Precinct showcasing the matrix's use and illustrating how the methodology discussed above can be applied to the Draft Route Network developed during this Study to produce a complete list of potential project ideas.

4.1 Route Suitability and Route Functionality Combined

The two measures, Suitability and Functionality analyses combine to provide a defendable approach for selecting roadway options to establish a Harris County Truck Route Plan. Figure 4.1 describes a Matrix that can be used to describe a methodology for selecting the County roads to make up the Truck Route Plan. Not every Level 1 route needs to be a high functionality to still be chosen as part of the system. Some Level 1 or 2 routes, without scoring high in functionality, may still rank high enough to enable them to qualify for truck route selection. Follow-up study efforts will afford the team an opportunity to rank options using the Figure 4.1 Matrix. The follow-up studies will allow for ranking and prioritizing truck route strategies, based on the framework established during the Phase 1 Study.

Figure 4.1 Harris County Truck Route Matrix



4.2 Infrastructure Project(s) Identification

Suitability and functionality analysis leading to choices in truck routes will result in identifying a means to develop an implementation plan. However, the plan requires further vetting of options, including identifying the cost of the improvements needed to bring a truck route segment to a standard of design to provide a long term service. Factors such as typical pavement section, horizontal geometry, lane widths, drainage improvements, and other features like improved driveways into industrial properties must be considered when implementing the Truck Route Plan.

Appendix C provides a discussion of four typical roadway options that could be adopted for segments of the truck routes. The options range from a solution where extensive volumes of freight hauled by truck is planned to an option of only making a pavement section improvement for a one-lane in each direction on a county road. The discussion goes on to offer unit costs for improvements, including a means for estimating the cost of bridge replacement. Also, included is a sampling of how this cost model could be applied for developing the cost of improvements to upgrade route segments, so comparisons and prioritization of improvements can be made.

It is anticipated, the next phases of the study will enable the Dannenbaum Engineering Team an opportunity to further develop the selected truck routes, including better defining the costs of the needed highway upgrades.

4.3 County-wide Issues

Harris County presents unique issues in developing a consistent and equitable approach in identifying a Truck Route Plan. The issues include such things as:

- Lack of zoning allows for the development of truck generated freight facilities in isolated areas making consistent and uniform approach to highway improvements impractical in some instances.
- High growth potential of the region is predicted to continue for the long term, meaning the need for solutions in handling freight travel by truck will continue.
- The location of the Port of Houston facilities are concentrated in one area of the County that will continue to require higher level of attention for accommodating truck route solutions.
- Funding solutions for needed improvements are and will continue to remain in strong competition with other infrastructure needs.

4.4 Next Steps and Recommendations

The Phase 1 Study has been structured in such a way that will provide the Harris County Engineering department a tool to initiate project development of truck route improvements, in priority order determined by the Precincts. Short or long term project initiatives have the potential to follow an adopted Truck Route Plan identified in this study.

In addition, an adopted truck route network may play an important role in:

- Making application for state, federal or special funding opportunities.
- Assist in future land developments focused on freight generators or transfer facilities.

Appendix A. Literature Review

The initial data review included the top 20 cities in the U.S. by population as well as any cities with a truck route methodology found during internet searches and locations where study team members were aware of previous truck route projects. The initial list of 20 U.S. cities were: New York, Los Angeles, Chicago, Houston, Philadelphia, Phoenix, San Antonio, San Diego, Dallas, San Jose, Austin, Jacksonville, San Francisco, Indianapolis, Columbus, Fort Worth, Charlotte, Seattle, Denver, and El Paso. Additional cities or regions examined include: Miami-Dade, FL; Alameda County, CA; Nashville, TN; Boston, MA; Rockland County, NY; Tampa, FL; Pinellas County, FL; and Atlanta, GA.

The following locations had maps and/or extensive documentation on methodology and were reviewed in more depth. Locations in *italics* are those with the most complete and detailed methodology available.

Table A.1 Truck Route Methodology Review Locations

Location	Map Available (Year)	Study or Methodology Available (Year)	OSOW Considered
Chicago, IL	*Yes(2013 Proposed)*	*Yes (2013)*	*Some consideration*
Los Angeles, CA	Yes (2010)	Yes (Multiple Phases 1999-2006)	No
New York City, NY	*Yes (2015)*	*Yes (2007)*	*Yes (due to NYC limits lower than state or Federal limits)*
Alameda County, CA	*Yes*	*Yes (2016)*	*No*
Miami-Dade, FL (MPO)	No	Yes (2007)	No
Atlanta Regional Commission, GA (MPO)	Yes (2010)	Yes (2010)	No
Nashville, TN	*No*	*Yes (2015)*	*No*
Texas (State DOT)	Yes	Yes (2014)	No
Pinellas County, FL (MPO)	Yes (2013)	Yes (2008)	No
Boston, MA	Yes (2003)	Yes (no date)	No
Tampa, FL	*Yes (2011)*	*Yes (2011)*	*No*
Rockland County, NY	Yes (2007)	Yes (2007)	No

Available documents including maps, technical reports, and studies for each city and region were reviewed in order to understand current U.S. practices for designating truck routes in large metropolitan areas.

After discussions arising from some of the initial stakeholder interviews, a further review was conducted of four additional East and Gulf Coast port cities that were considered peer cities to Houston/Harris County: Norfolk, Charleston, Savannah, and New Orleans. This review found that three of the four cities had no comprehensive truck route network. The New Orleans 2030 Plan[8] references a Heavy Truck Routes network designated by the City of New Orleans, and includes a

[8] http://www.nola.gov/getattachment/3821a858-c9c1-499a-964a-5c0ec83a65f4/Vol-3-Ch-11-Transportation/

map showing a portion of the City, but research was not able to identify a map or other document showing the system in its entirety or any report or study explaining the development of the network.

A 2002 Study for the South Carolina Department of Commerce titled “Container Movements and Traffic Mitigation Measures” examined the quantity and nature of port related truck traffic in Charleston, identified potential mitigation strategies, and evaluated costs and benefits of implementing such strategies. Truck counts, Origin and Destination surveys, and a truck trip assignment model were used to determine how trucks were entering and exiting the port facility, but this data was not subsequently used to designate a truck route network.

Appendix B. Data Sources

Table B.1 identifies data collected by the study team that from publically available sources. These data elements either already were in or were converted to a Geographic Information System (GIS) format for analysis. This data was used to identify highway ownership (State, county, municipal, private), existing designations, land uses that are most likely to generate or attract significant truck traffic, and potential impediments to truck travel that truck routes should avoid whenever practical.

Table B.1 Data Compiled by the Project Team from Existing Public Sources

Data Type	Data Name	Purpose	Source	Notes
Highway	FHWA Intermodal Connectors	Intermodal Connectors are roads that connect freight facilities to the main highway network. High truck volumes.	FHWA	
	Texas DOT State Truck Routes	Primary and Secondary roads that carry majority of long-distance truck traffic. County routes should link to these.	Texas DOT (from ArcGIS)	
	TxDOT Traffic Counts	Truck Volumes on state routes to help identify key corridors.	Texas DOT	
	HGAC Regional Goods Movement Study Recommended Truck Routes	Recommended regional freight routes are roads that should carry the majority of regional truck traffic.	HGAC Study-Prior CS Work	
	Grade Crossing Locations	At-grade crossings can offer geometric challenges for trucks and can cause delays.	FRA Grade Crossing Database	
Land Use	HGAC Freight Finder Tool – Business Directory	Businesses identified in study as freight businesses. Likely to generate or attract truck traffic.	HGAC Study-Prior CS Work	
	Harris County Land Use	Will identify commercial, industrial, agricultural, and manufacturing uses. These likely generate or attract truck traffic.	Houston Online Data Portal	January 2014
	RMP Facilities (Chemical companies required by EPA to file risk management plans)	Potential truck generating facilities.	U.S. Environmental Protection Agency	
	Petroleum refineries	Potential truck generating facilities.	U.S. Energy Information Administration	
	Power plants	Potential truck generating facilities.	U.S. Energy Information Administration	
	Ethylene crackers	Potential truck generating facilities.	U.S. Energy Information Administration	
	School Locations	Vulnerable land uses. Truck routes will try to avoid these.	City of Houston GIS Open Data	

	Hospital Locations	Vulnerable land uses. Truck routes will try to avoid these. However, must be balanced with need for trucks to serve hospital freight needs.	City of Houston GIS Open Data	
Political	Harris County Commissioner Precincts	Locations of Commissioner Precincts.	City of Houston GIS Open Data	
Socio-economic	Population and Population Density	Truck routes should try to avoid areas with a high population density when possible.	U.S. Census Bureau	2010, Census Block level

Table B.2 identifies data used in the analysis that was received from the Harris County project manager.

Table B.2 Data Compiled by the Project Team from Harris County

Data Name	Purpose	Notes
Harris County (HC) Owned Highway Network	Roads owned by Harris County are the target of this study.	No roads in City of Houston. From TxDOT RHINO data.
County Road Truck Counts	Truck counts will show where trucks are currently traveling and will help identify key truck corridors.	Constant factor used for all county roads. From TxDOT RHINO data.
Transit Network (Bus and Rail)	Truck routes should try to avoid conflicts with transit networks when possible.	
Bicycle Routes and Bike/Pedestrian Trails	Truck routes should try to avoid conflicts with bicycle routes and major pedestrian and bicycle paths when possible.	
Container Freight Stations	Potential truck generator. These are warehouses where containerized shipments are constructed/deconstructed.	
U.S. Customs and Border Protection Firms	Potential truck generator. USCBP Firms are authorized to handle international shipments moving in-bond (sealed).	
U.S. Bureau of Transportation Statistics Intermodal Terminal Facilities	Intermodal facilities are locations where goods transfer between modes of transport. Key generators and attractors of trucks when truck mode is included.	
Port of Houston Facilities	Major generators of truck activity.	

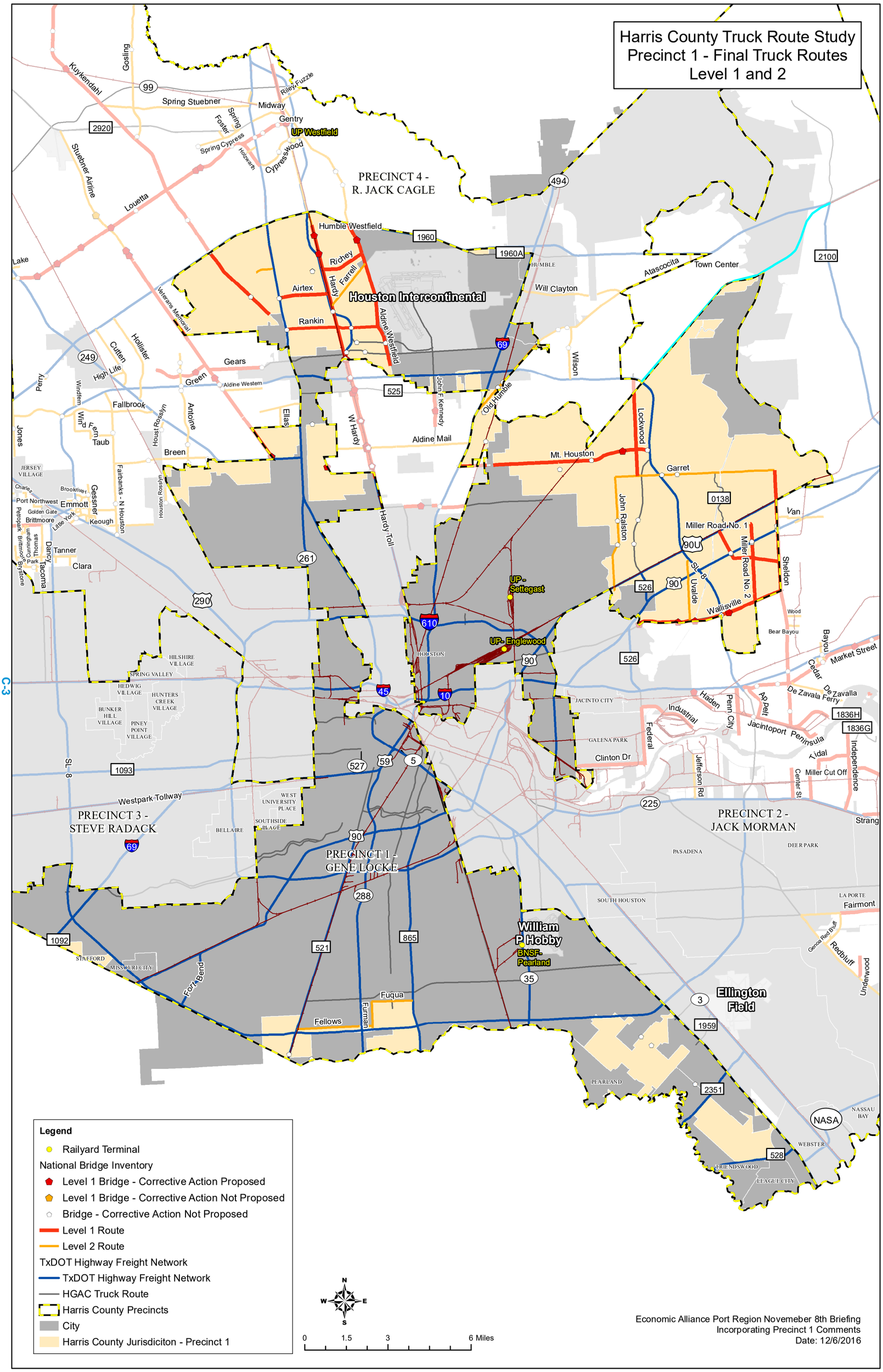
Appendix C. Route Evaluation and Results

C.1 Summary

The results of analyzing the functionality of the various route options are illustrated in Appendix C, and are used to support the findings as illustrated on the Level 1 & 2 Truck Route Maps by Precinct.

In addition, the cost model used for identifying the cost of route improvement options is explained in greater detail in the following pages. This cost model may be used by Harris County Engineering and others to develop costs for planning future project improvements. It is anticipated, as part of the next phases in the development of the Harris County Truck Route Plan, the Dannenbaum Engineering Planning Team will further refine this cost model, and apply the model to determine preliminary costs for implementing improvements to specific routes.

C.2 Level 1 and 2 Truck Routes Analysis by Precinct


Harris County Truck Route Study
Precinct 1 - Final Truck Routes
Level 1 and 2
PRECINCT 4 -
R. JACK CAGLE
PRECINCT 3 -
STEVE RADACK
PRECINCT 1 -
GENE LOCKE
PRECINCT 2 -
JACK MORMAN
Houston Intercontinental
William P Hobby
Ellington Field
UP Westfield
UP- Settegast
UP- Englewood
BNSF- Pearland
Humble Westfield
Aldine Mail
Mt. Houston
Will Clayton
Atascocita
Town Center
Miller Road No. 1
Miller Road No. 2
Wallisville
Clinton Dr
Westpark Tollway
Fuqua
Fellows
Furman
Fort Bend
Hardy Toll
Aldine Westfield
John F Kennedy
Old Humble
John Ralston
Lockwood
Sheldon
Uvalde
Jacintoport Peninsula
Penn City
Haden
Industrial
Federal
Jefferson Rd
Center St
Miller Cut Off
Independence
Tidal
Bayou
Cedar
Market Street
De Zavalla
De Zavala Ferry
Apelt
Strang
Fairmont
Redbluff
Underwood
Garret
Van
Wood
Bear Bayou
Legend
Railyard Terminal
National Bridge Inventory
Level 1 Bridge - Corrective Action Proposed
Level 1 Bridge - Corrective Action Not Proposed
Bridge - Corrective Action Not Proposed
Level 1 Route
Level 2 Route
TxDOT Highway Freight Network
TxDOT Highway Freight Network
HGAC Truck Route
Harris County Precincts
City
Harris County Jurisdiciton - Precinct 1
N
W
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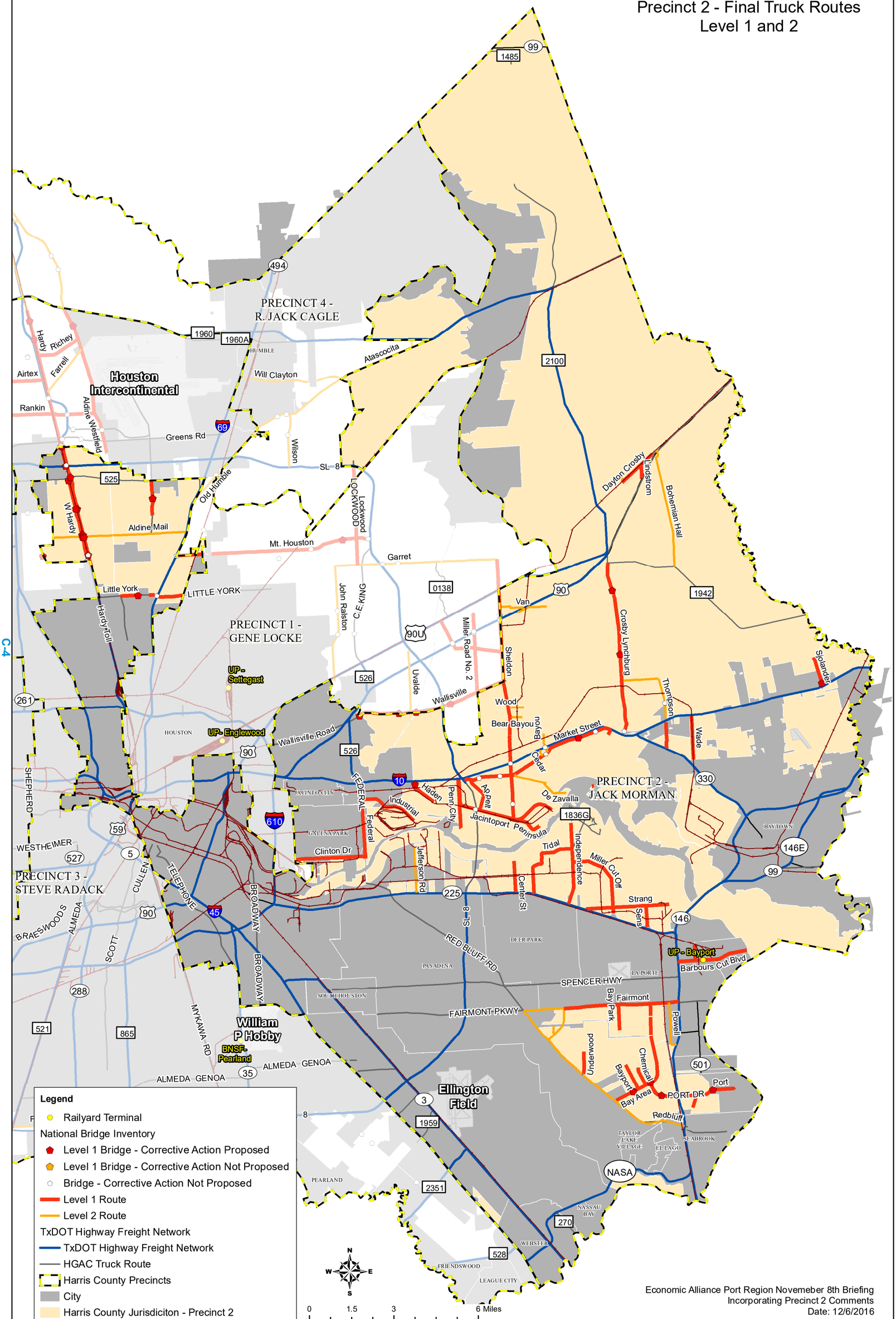
0
1.5
3
6 Miles
Economic Alliance Port Region Novemeber 8th Briefing
Incorporating Precinct 1 Comments
Date: 12/6/2016

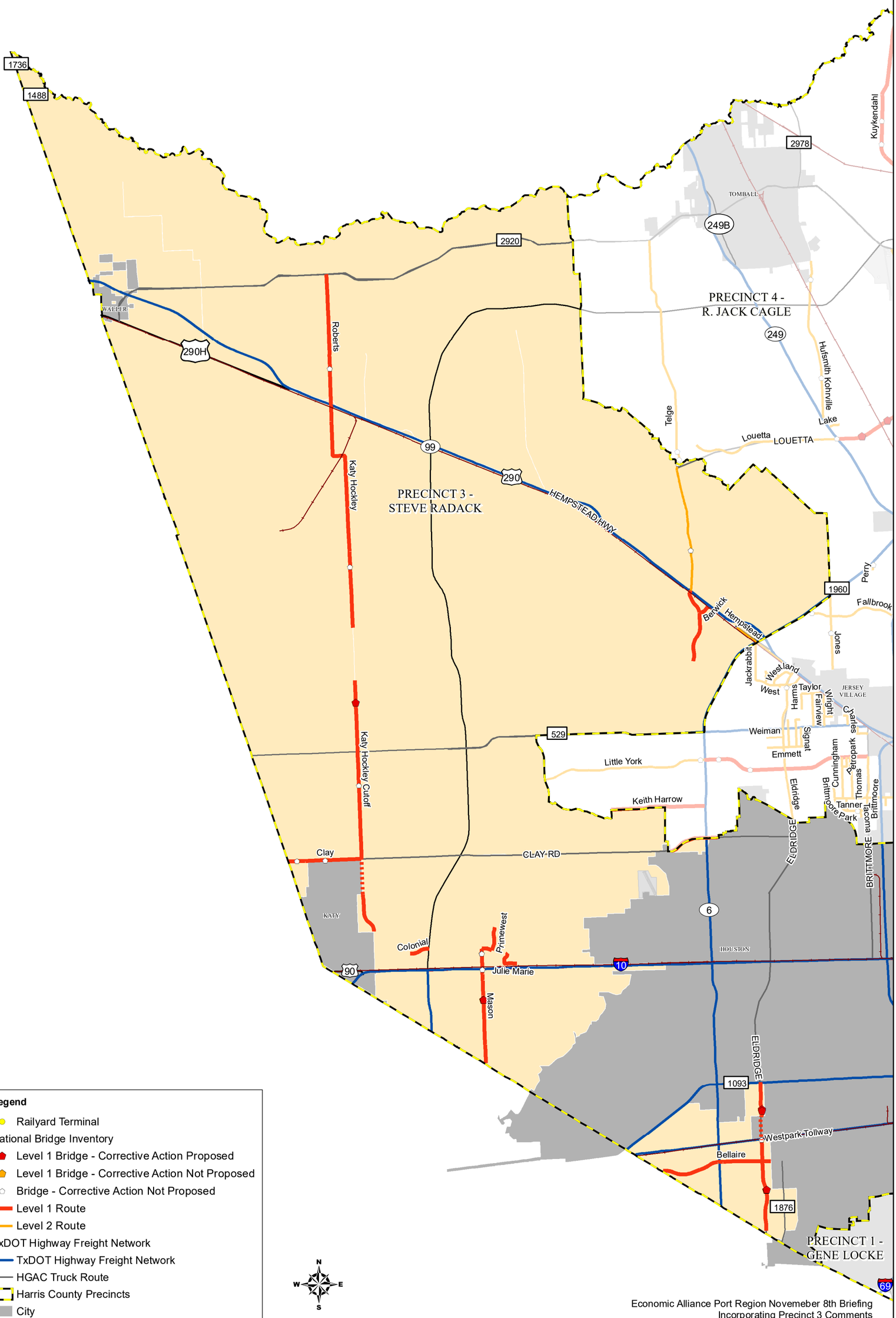
Harris County Truck Route Study
Precinct 2 - Final Truck Routes
Level 1 and 2



C-4

Economic Alliance Port Region Novemeber 8th Briefing
Incorporating Precinct 2 Comments
Date: 12/6/2016

Harris County Truck Route Study
Precinct 3 - Final Truck Routes
Level 1 and 2



Legend

- Railyard Terminal

National Bridge Inventory

- Level 1 Bridge - Corrective Action Proposed
- Level 1 Bridge - Corrective Action Not Proposed
- Bridge - Corrective Action Not Proposed
- Level 1 Route
- Level 2 Route

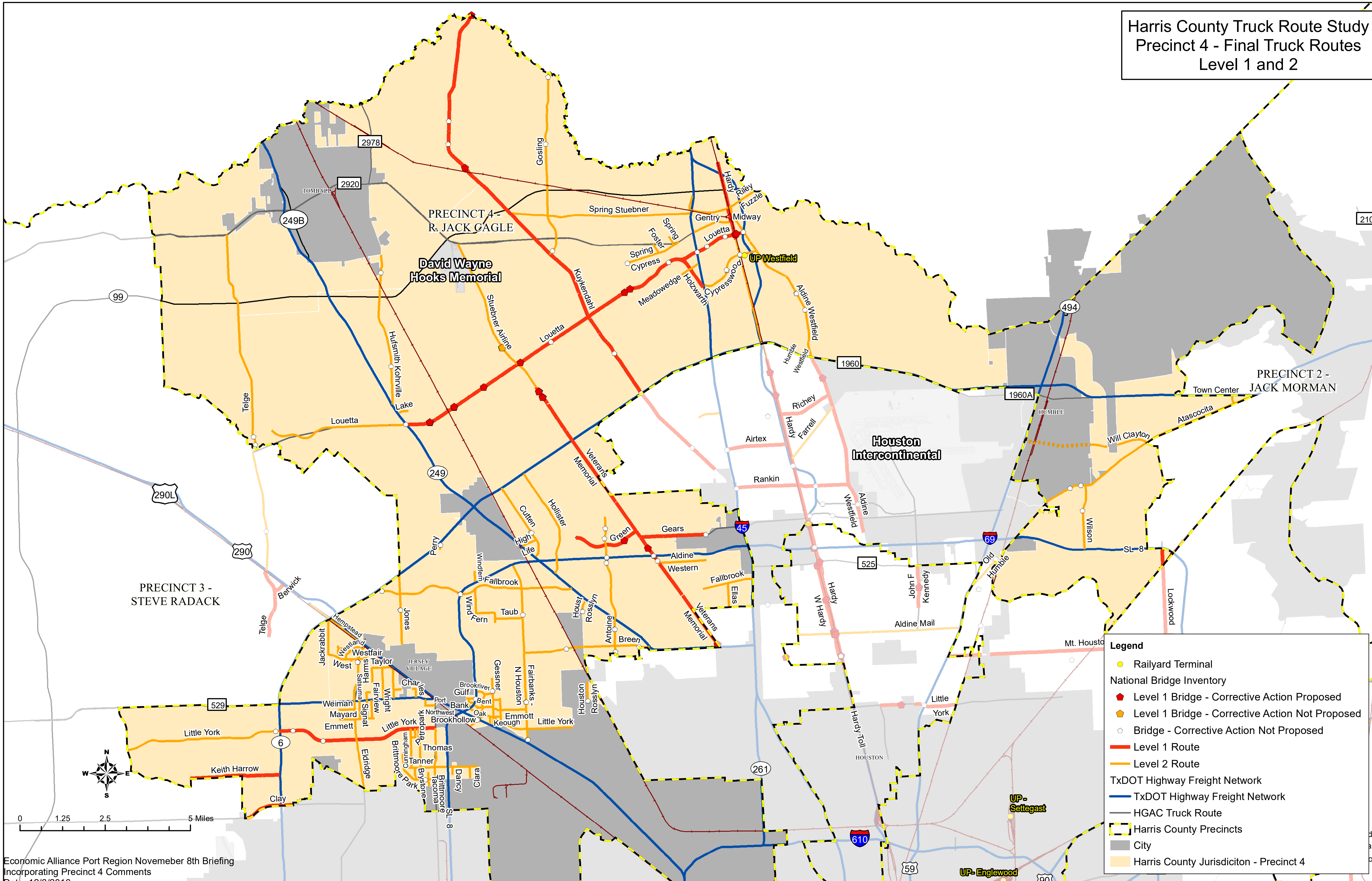
TxDOT Highway Freight Network

- TxDOT Highway Freight Network
- HGAC Truck Route
- Harris County Precincts
- City
- Harris County Jurisdiciton - Precinct 3

N W E S

0 1.25 2.5 5 Miles

Economic Alliance Port Region Novemeber 8th Briefing
Incorporating Precinct 3 Comments
Date: 12/6/2016


Harris County Truck Route Study
Precinct 4 - Final Truck Routes
Level 1 and 2
PRECINCT 4 - R. JACK CAGLE
PRECINCT 3 - STEVE RADACK
PRECINCT 2 - JACK MORMAN
David Wayne Hooks Memorial
Houston Intercontinental
UP Westfield
UP - Settegast
UP- Englewood
TOMBALL
HUMBLE
JERSEY VILLAGE
HOUSTON
SPRING VALLEY
Spring Stuebner
Louetta
Kuykendahl
Stuebner Airline
Hufsmith Kohrville
Gosling
Telge
Lake
Cypresswood
Meadowedge
Holzwarth
Aldine Westfield
Veterans Memorial
Gears
Green
Aldine
Western
Fallbrook
Ellas
Rankin
Airtex
Richey
Farrell
Hardy
W Hardy
Hardy Toll
John F Kennedy
Aldine Mail
Mt. Houston
Little York
Lockwood
Wilson
Will Clayton
Atascocita
Town Center
Old Humble
Cutten
Hollister
High Life
Perry
Windfern
Wind Fern
Taub
Jones
Breen
Antoine
Rosslyn
Gessner
N Houston
Fairbanks
Berwick
Hempstead
Westland
Westfair
West
Taylor
Jackrabbit
Weiman
Mayard
Emmett
Signat
Fairview
Wright
Eldridge
Thomas
Tanner
Clara
Dancy
Brookhollow
Keith Harrow
Clay
Little York
249B
2978
2920
99
290L
290
249
1960
1960A
494
2100
525
261
529
6
45
69
610
59
90
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0 1.25 2.5 5 Miles
Legend
Railyard Terminal
National Bridge Inventory
Level 1 Bridge - Corrective Action Proposed
Level 1 Bridge - Corrective Action Not Proposed
Bridge - Corrective Action Not Proposed
Level 1 Route
Level 2 Route
TxDOT Highway Freight Network
TxDOT Highway Freight Network
HGAC Truck Route
Harris County Precincts
City
Harris County Jurisdiciton - Precinct 4
Economic Alliance Port Region Novemeber 8th Briefing
Incorporating Precinct 4 Comments
Date: 12/6/2016

Level 1 Routes – Bridges							BRINSAP Assessment					
	Area	Precinct	Route	Over/ Under	Crossing	Structure ID	Age	Sufficiency Rating	Struct Defcnt	Funct Obsol	Corrective Action	Widen or Replace
1	Airport/Hardy Rd	1	AIRTEX DR.	UNDER	IH 45 NB	121020011005143	19	83				
2	Airport/Hardy Rd	1	AIRTEX DR	UNDER	IH 45 SB & HOV	121020011005145	19	94		FO		
3	Airport/Hardy Rd	1	RANKIN RD	UNDER	IH 45 NB	121020011006141	19	90				
4	Airport/Hardy Rd	1	HARDY TOLL RD & UPRR	UNDER	BW 8	121020325602004	48	67		FO	Yes	Replace
5	Airport/Hardy Rd	1	ALDINE WESTFLD SB	OVER	TURKEY CREEK	121020AA5744004	17	77				
6	Airport/Hardy Rd	1	ALDINE WESTFLD NB	OVER	TURKEY CREEK	121020AA5744005	17	71		FO	Yes	Widen
7	Airport/Hardy Rd	1	E HARDY RD	OVER	HCFCD DITCH	121020AA5775030	76	67		FO	Yes	Replace
8	Airport/Hardy Rd	1	HARDY TOLL RD	OVER	UP RR & HARDY RD	121020TOL040201	27	91				
9	Airport/Hardy Rd	1	HARDY TOLL RD	OVER	ALDINE-WESTFIELD	121020TOL040204	26	93				
10	Airport/Hardy Rd	1	HARDY TOLL RD	OVER	UPRR & E HARDY RD	121020TOL040214	27	93				
11	Airport/Hardy Rd	1	HARDY TOLL RD & CONNS	UNDER	IAH CONN C	121020TOL010101	16	92		FO		
12	Airport/Hardy Rd	1	CENTRAL GREEN BLVD	UNDER	IAH CONN	121020TOL010103	16	100				
13	Airport/Hardy Rd	1	AIR CENTER BLVD	UNDER	IAH CONNECTOR	121020TOL010104	16	100				
14	Airport/Hardy Rd	4	LOUETTA RD	OVER	IH 45	121020011005153	22	97				
15	Airport/Hardy Rd	4	E LOUETTA RD	OVER	WUNSCHE GULLY	121020AA2111015	16	86				
16	Airport/Hardy Rd	1,2	HARDY TOLL RD SB	OVER	UP RR & HCFCD DITCH	121020TOL040219	29	94				
17	Airport/Hardy Rd	3,4	ALDINE WESTFIELD RD	UNDER	IAH CONN	121020TOL010106	16	99				
18	Channelview	2	SHELDON RD	UNDER	US 90 WB	121020002802178	29	93				
19	Channelview	2	SHELDON RD	UNDER	US 90 EB	121020002802179	29	98				
20	Channelview	2	US 90 ACCESS RD	OVER	DRAINAGE DITCH	121020002802180	29	90				
21	Channelview	2	MILLER ROAD #3	UNDER	US 90 EB	121020002802203	26	97				
22	Channelview	2	MILLER ROAD #3	UNDER	US 90 WB	121020002802204	26	97				
23	Channelview	2	MILLER ROAD #2	UNDER	US 90 EB	121020002802205	26	97				
24	Channelview	2	MILLER ROAD #2	UNDER	US 90 WB	121020002802206	26	97				
25	Channelview	2	SHELDON RD	OVER	NORTH DITCH # 1	121020002802207	26	97				
26	Channelview	2	SHELDON RD	UNDER	IH 10	121020050801260	34	98				
27	Channelview	2	UP RR & JACINTO PORT BLV	UNDER	BW 8	121020325603076	36	82				
28	Channelview	2	WALLISVILLE RD	UNDER	BW 8	121020325603258	22	96		FO		
29	Channelview	2	SHELDON RD	OVER	HCFCD DITCH	121020AA4536001	26	85				
30	Channelview	2	SHELDON ACCESS RD	OVER	HCFCD DITCH	121020AA4536002	6	84				
31	Channelview	2	WALLISVILLE RD	OVER	GREENS BAYOU	121020AA4541001	30	67		FO	Yes	Widen
32	Channelview	2	WALLISVILLE RD	OVER	WEST CANAL	121020AA4541002	34	67		FO	Yes	Widen
33	Channelview	2	Wallisville Rd	OVER	Big Gulch	121020AA4541003	30	67		FO	Yes	Widen
34	Channelview	2	WALLISVILLE RD	OVER	CARPENTERS BAYOU	121020AA4541004	34	68		FO	Yes	Widen
35	Channelview	2	S SHELDON RD	OVER	CARPENTERS BAYOU	121020AA4826001	41	87				
36	Channelview	2	MARKET ST	OVER	CARPENTERS BAYOU	121020AA4850001	76	76				
37	Channelview	2	MARKET ST	OVER	CARPENTERS BAYOU TRIB	121020AA4850002	76	88				
38	Channelview	2	MARKET ST	OVER	FRESH WATER BYU	121020AA4850003	11	73				

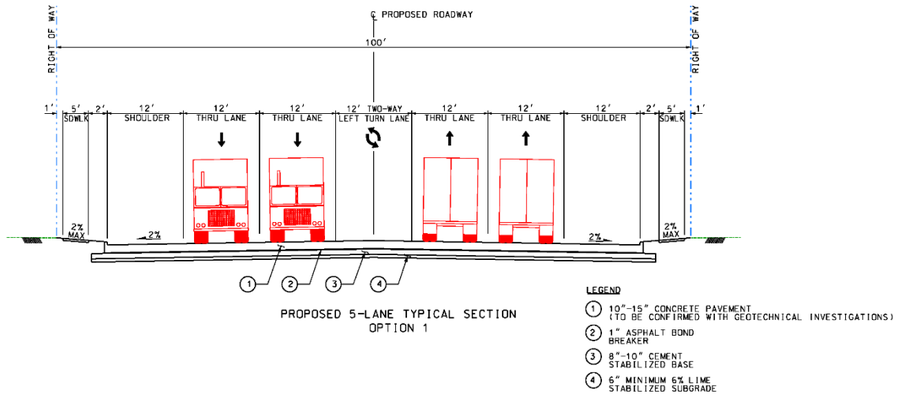
Level 1 Routes – Bridges							BRINSAP Assessment					
39	Channelview	2	MARKET ST	OVER	SAN JAC RI REL	121020AA4850004	26	72			Yes	Widen
40	Channelview	2	MARKET ST	OVER	SAN JAC RI REL	121020AA4850006	30	75				
41	Channelview	2	HADEN RD	OVER	HCFCD DITCH	121020AA4853001	28	81			Yes	Widen
42	East	2	CROSBY-LYNCH NB	OVER	IH 10	121020050801223	45	72		FO	Yes	Replace
43	East	2	CROSBY-LYNCH SB	OVER	IH 10	121020050801240	45	72		FO	Yes	Replace
44	East	2	SJOLANDER RD	OVER	MCGEE GULLY	121020AA3375004	27	88			Yes	Widen
45	East	2	CROSBY LYNCHBURG	OVER	HCFCD DITCH	121020AA9962001	26	65		FO	Yes	Widen
46	East	2	CROSBY LYNCHBURG	OVER	BLUFF GULLY	121020AA9962002	56	86			Yes	Widen
47	East	2	CROSBY-LYNCHBURG	OVER	LYNCHBURG RES. CANAL	121020AA9962003	46	85				
48	Jersey Village/Northwest	3	Mason Rd.	UNDER	IH 10 WB	121020027106538	11	87				
49	Jersey Village/Northwest	3	Mason Rd	UNDER	IH 10 EB	121020027106539	11	87				
50	Jersey Village/Northwest	3	S MASON RD SB	OVER	HCFCD DITCH	121020AA2581001	46	63		FO	Yes	Widen
51	Jersey Village/Northwest	3	S MASON RD NB	OVER	HCFCD DITCH	121020AA2581005	35	74		FO	Yes	Widen
52	Jersey Village/Northwest	4	LOUETTA RD	UNDER	SH 249	121020072003068	19	98				
53	Jersey Village/Northwest	4	LOUETTA RD EB	OVER	PILLOT GULLY	121020AA2111003	34	69		FO	Yes	Widen
54	Jersey Village/Northwest	4	LOUETTA RD EB	OVER	HCFCD DITCH K137-00-00	121020AA2111004	34	69		FO	Yes	Widen
55	Jersey Village/Northwest	4	LOUETTA RD	OVER	DRY GULLY	121020AA2111005	38	64		FO	Yes	Widen
56	Jersey Village/Northwest	4	LOUETTA RD	OVER	THEISS GULLY	121020AA2111006	40	71		FO	Yes	Widen
57	Jersey Village/Northwest	1,2	LOUETTA RD	OVER	SPRING GULLY	121020AA2111007	31	85				
58	Jersey Village/Northwest	1,2	LOUETTA RD	OVER	SEALS GULLY	121020AA2111008	30	80		FO	Yes	Widen
59	Jersey Village/Northwest	1,2	LOUETTA RD	OVER	KOTHMAN GULLY	121020AA2111009	30	75		FO	Yes	Widen
60	Jersey Village/Northwest	4	LOUETTA RD	OVER	SENGER GULLY	121020AA2111010	30	82				
61	Jersey Village/Northwest	4	LOUETTA RD WB	OVER	PILLOT GULLY	121020AA2111011	26	69		FO	Yes	Widen
62	Jersey Village/Northwest	4	LOUETTA RD WB	OVER	HCFCD DITCH K137-00-00	121020AA2111012	26	69		FO	Yes	Widen
63	Jersey Village/Northwest	4	LOUETTA RD EB	OVER	UNION PACIFIC RAILROAD	121020AA2111013	27	69		FO	Yes	Widen
64	Jersey Village/Northwest	4	LOUETTA RD WB	OVER	UNION PACIFIC RAILROAD	121020AA2111014	34	69		FO	Yes	Widen
65	Jersey Village/Northwest	4	LOUETTA RD	OVER	LEMM GULLY	121020AA8893001	33	85				
66	La Porte	2	UP RR & PORT ROAD	UNDER	SH 146 NB	121020038905059	47	97				
67	La Porte	2	UP RR & PORT ROAD	UNDER	SH 146 SB	121020038905101	47	99				
68	La Porte	2	PORT DR.	OVER	TAYLOR BAYOU	121020AA3274001	46	70		FO	Yes	Widen
69	La Porte	2	OLD PORT DR	OVER	HCFCD DITCH	121020AA3274002	41	37	SD		Yes	Replace
70	La Porte	2	BAY AREA BLVD EB	OVER	HCFCD DITCH	121020AA9958001	46	68		FO	Yes	Widen
71	La Porte	2	BAY AREA BLVD WB	OVER	HCFCD DITCH	121020AA9958002	46	68		FO	Yes	Widen
72	La Porte	4	BAY AREA BLVD WB	OVER	HCFCD DITCH	121020AA9958003	48	70		FO	Yes	Widen
73	La Porte	1,4	BAY AREA BLVD EB	OVER	HCFCD DITCH	121020AA9958004	48	70		FO	Yes	Widen
74	Mission Bend	1,4	ELDRIDGE PKWY NB	OVER	HCFCD DITCH	121020AA9648005	30	70		FO	Yes	Widen
75	Mission Bend	3	ELDRIDGE PKWY SB	OVER	HCFCD DITCH	121020AA9648006	30	78		FO	Yes	Widen
76	Mission Bend	3	ELDRIDGE RD NB	OVER	N FK BRAYS BYU	121020AA9648007	29	70		FO	Yes	Widen

Level 1 Routes – Bridges							BRINSAP Assessment					
77	Mission Bend	3	ELDRIDGE RD SB	OVER	N FK BRAYS BYU	121020AA9648008	29	70		FO	Yes	Widen
78	Mission Bend	3	ELDRIDGE PARKWAY	UNDER	WESTPARK TOLLWAY	121020TOL030033	11	100				
79	North	4	KUYKENDAHL RD	OVER	WILLOW CREEK	121020AA0681001	25	67		FO	Yes	Widen
80	North	4	KUYKENDAHL RD	OVER	CANNON GULLY	121020AA0681002	24	86				
81	North	4	KUYKENDAHL RD	OVER	METZLER GULLY	121020AA0681003	25	89				
82	North	4	KUYKENDAHL RD	OVER	SPRING CREEK	121020AA0681004	31	61		FO	Yes	Widen
83	North	4	STUEB AIRLINE (SB)	OVER	THEISS GULLY	121020AA2112001	22	70		FO	Yes	Widen
84	North	4	STUEB AIRLINE (NB)	OVER	CYPRESS CREEK RELIEF	121020AA2112002	31	69		FO	Yes	Widen
85	North	4	STUEB AIRLINE (NB)	OVER	CYPRESS CREEK	121020AA2112003	31	69		FO	Yes	Widen
86	North	4	STUEB AIRLINE (SB)	OVER	CYPRESS CREEK	121020AA2112008	31	69		FO	Yes	Widen
87	North	4	STUEB AIRLINE (SB)	OVER	CYPRESS CREEK RELIEF	121020AA2112009	31	69		FO	Yes	Widen
88	North	4	STUEB AIRLINE (NB)	OVER	THEISS GULLY	121020AA2112010	19	70		FO	Yes	Widen
89	Northwest	3	ROBERTS RD	UNDER	US 290	121020005006158	12	98				
90	Northwest	3	KATY HOCKLEY RD	OVER	DRAINAGE DITCH	121020AA0200001	56	81				
91	Northwest	1,4	KATY HOCKLEY CUTFF	OVER	S MAYDE CR	121020AA0201001	27	88				
92	Northwest	3	KATY HOCKLEY CUTOF	OVER	BEAR CREEK	121020AA0201002	23	79			Yes	Widen
93	Northwest	3	KATY HOCKLEY RD	OVER	CYPRESS CREEK	121020AA0201003	33	79				
94	Northwest	3	CLAY RD	OVER	CANE ISLAND BR	121020AA0234001	25	91				
95	Northwest	3	ROBERTS RD	OVER	LITTLE CYPRESS CREEK	121020AA0575001	25	90				
96	Northwest Remainder	4	GEARS RD	OVER	GREENS BAYOU	121020AA5965001	33	84				
97	Northwest Remainder	4	W GREENS RD	OVER	GREENS BAYOU	121020AA6012002	34	78		FO	Yes	Widen
98	Northwest Remainder	4	LEXINGTON RD	OVER	LEMM GULLY	121020AA2063003	28	75				
99	Northwest Remainder	1,4	VETERANS MEMORIAL DR	UNDER	BW 8 EBML	121020325602227	27	95				
100	Northwest Remainder	1,4	VETERANS MEMORIAL DR	UNDER	BW 8 WBML	121020325602228	27	95				
101	Northwest Remainder	1,4	VETS MEMORIAL DR	OVER	GREENS BAYOU	121020AA2112004	37	61		FO	Yes	Widen
102	Northwest Remainder	2,4	VETS MEMOR DR NB	OVER	HALLS BAYOU	121020AA2112005	36	69		FO	Yes	Widen
103	Northwest Remainder	1,4	VETS MEMOR DR SB	OVER	HALLS BAYOU	121020AA2112006	36	69		FO	Yes	Widen
104	Northwest Remainder	1,4	VETS MEMORIAL DR	OVER	HCFCD DITCH	121020AA2112007	46	70				
105	Sheldon	1	BW 8 E	OVER	LAKE HOUSTON PKWY	121020325603483	5	92				
106	Sheldon	1	N LAKE HOU PKWY	OVER	GREENS BAYOU	121020AA4351001	29	91				
107	Sheldon	1	N LAKE HOUSTON PKY	OVER	HCFCD DITCH	121020AA4351002	29	68		FO	Yes	Widen
108	Sheldon	2	LITTLE YORK RD	UNDER	US 59	121020017707177	21	96				
109	Sheldon	2,4	MOUNT HOUSTON RD	UNDER	US 59 SB & HOV	121020017707189	18	93				
110	South	1	FM 521	OVER	DRAINAGE DITCH	121020011101023	67	82				
111	South of Airport	1	HARDY TOLL RD	OVER	BW 8 FRS	121020325602096	26	95		FO		
112	South of Airport	1,2	E HARDY RD	OVER	TURKEY CREEK	121020AA5775031	35	69		FO	Yes	Widen
113	South of Airport	1,2	HARDY TOLL RD	OVER	RANKIN RD	121020TOL040215	27	99				
114	South of Airport	1	JFK BLVD SB	OVER	BW 8	121020325602115	26	79		FO	Yes	Widen
115	South of Airport	1	E HARDY RD SB	OVER	GREENS BAYOU	121020AA5775045	38	67		FO	Yes	Widen
116	South of Airport	1,2	E HARDY RD NB	OVER	GREENS BAYOU	121020AA5775046	29	71		FO	Yes	Widen

Level 1 Routes – Bridges							BRINSAP Assessment					
117	South of Airport	1,2	AIRLINE DR WEST RD	OVER	HCFCD DITCH	121020AA6011001	66	72				
118	South of Airport	1	AIRLINE DR	OVER	HALLS BAYOU	121020AA6011002	29	84		FO	Yes	Widen
119	South of Airport	2	W HARDY RD	OVER	S APPROACH TO FM 525	121020AA5775035	29	79		FO	Yes	Widen
120	South of Airport	2	E HARDY RD	OVER	S APPROACH TO FM 525	121020AA5775036	29	79		FO	Yes	Widen
121	South of Airport	1	E HARDY RD	OVER	HCFCD DITCH	121020AA5775037	29	72		FO	Yes	Widen
122	South of Airport	1	W HARDY RD	OVER	HCFCD DITCH	121020AA5775038	38	55		FO	Yes	Widen
123	South of Airport	1	W HARDY RD SB	OVER	S APPR TO ALDINE MAIL RT	121020AA5775042	29	76		FO	Yes	Replace
124	South of Airport	3,4	E HARDY RD NB	OVER	S APPR TO ALDINE MAIL RT	121020AA5775043	29	76		FO	Yes	Replace
125	South of Airport	2	W HARDY RD	OVER	N APPROACH TO FM 525	121020B30225003	29	95		FO	Yes	Widen
126	South of Airport	2	LITTLE YORK RD EB	OVER	HALLS BAYOU	121020B39913609	8	79		FO	Yes	Widen
127	South of Airport	2	LITTLE YORK RD WB	OVER	HALLS BAYOU	121020B39913610	33	68		FO	Yes	Widen
128	South of Airport	2	HARDY TOLL RD NB	OVER	HCFCD DITCH	121020TOL040220	29	94				
129	South of Airport	1,2	HARDY TOLL RD	OVER	GREENS BAYOU	121020TOL040217	28	100				
130	South of Airport	1,2	HARDY TOLL RD	OVER	OLD GREENS RD	121020TOL040218	30	93				
131	South of Airport	1,2	W HARDY RD SB	OVER	N APPR TO ALDINE MAIL RT	121020AA5775040	29	76		FO	Yes	Replace
132	South of Airport	1,2	E HARDY RD NB	OVER	N APPR TO ALDINE MAIL RT	121020AA5775041	29	77		FO	Yes	Replace
133	South of Airport	1	JFK BLVD NB	OVER	GREENS BAYOU	121020AA6349001	29	70		FO	Yes	Widen
134	South of Airport	1	JFK BLVD SB	OVER	GREENS BAYOU	121020AA6349002	29	70		FO	Yes	Widen
135	South of Airport	4	W HARDY RD	OVER	HALLS BAYOU	121020AA5775039	29	73		FO	Yes	Widen
136	South of Airport	1	HARDY TOLL RD SB	OVER	HALLS BAYOU	121020TOL040221	29	94				
137	South of Airport	1	HARDY TOLL RD NB	OVER	HALLS BAYOU	121020TOL040222	29	93				

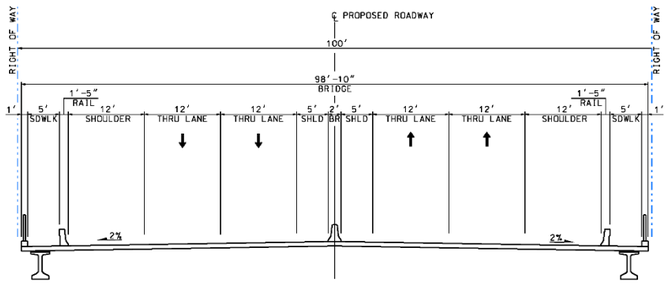
C.3 Roadway and Bridge Typical Section Options

Figure C.1 Typical Sections – Option 1

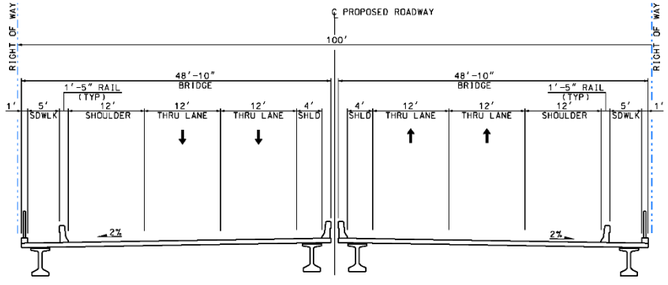


PROPOSED 5-LANE TYPICAL SECTION
OPTION 1

LEGEND
1. 10"-15" CONCRETE PAVEMENT (TO BE CONFIRMED WITH GEOTECHNICAL INVESTIGATIONS)
2. 1" ASPHALT BOND BREAKER
3. 8"-10" CEMENT STABILIZED BASE
4. 6" MINIMUM 6% LIME STABILIZED SUBGRADE

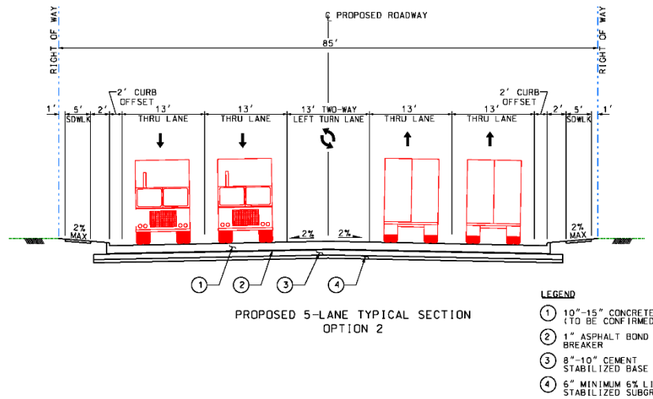


PROPOSED 5-LANE TYPICAL SECTION
OPTION 1 – SINGLE BRIDGE



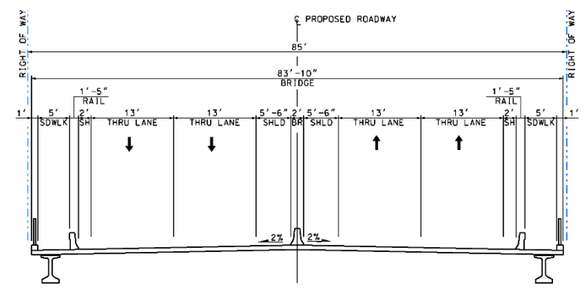
PROPOSED 5-LANE TYPICAL SECTION
OPTION 1 – DUAL BRIDGES

Figure C.2 Typical Sections – Option 2

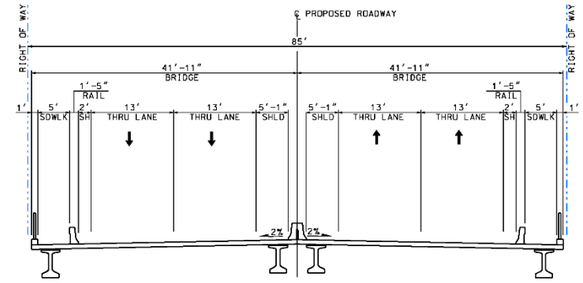


PROPOSED 5-LANE TYPICAL SECTION
OPTION 2

LEGEND
1. 10"-15" CONCRETE PAVEMENT (TO BE CONFIRMED WITH GEOTECHNICAL INVESTIGATIONS)
2. 1" ASPHALT BOND BREAKER
3. 8"-10" CEMENT STABILIZED BASE
4. 6" MINIMUM 6% LIME STABILIZED SUBGRADE

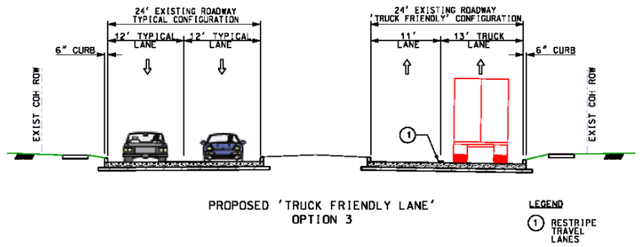


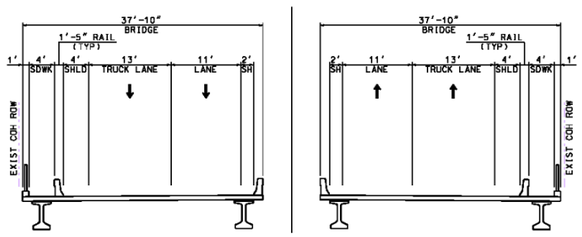
PROPOSED 5-LANE TYPICAL SECTION
OPTION 2 – SINGLE BRIDGE



PROPOSED 5-LANE TYPICAL SECTION
OPTION 2 – DUAL BRIDGES

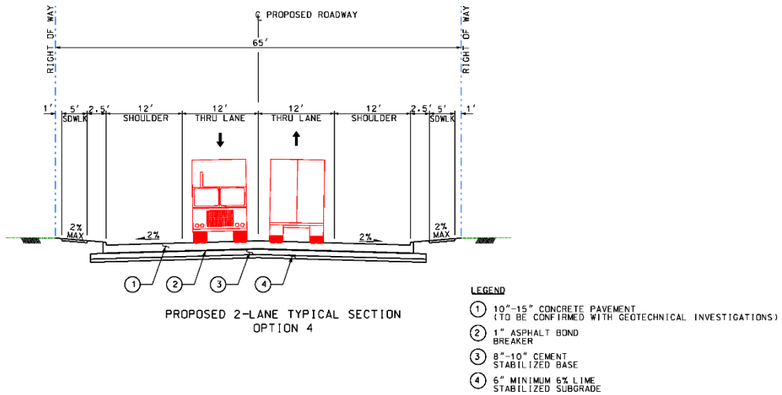
Figure C.3 Typical Sections – Option 3

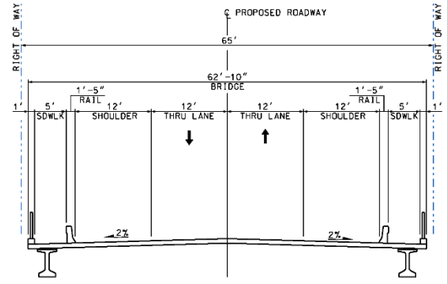




PROPOSED 'TRUCK FRIENDLY LANE'
OPTION 3 – DUAL BRIDGES

Figure C.4 Typical Sections – Option 4





PROPOSED 2-LANE TYPICAL SECTION
OPTION 4 – SINGLE BRIDGE

C.4 Planning Level Unit Cost Factors

C.4.1 Basis for Estimated Cost of Improvements (Current 2016 Costs*)*

***From TxDOT FY 2016 Unit Costs**

1. **Replace Roadway with 5-lane Typical Section, Option 1**
   a. Roadway = $7,208,000/mile
   b. Striping = $75,000/mile
   c. Signing = $25,000/mile
   d. Storm Sewer = $2,700,000/mile
   e. Total: <u>$10,008,000/mile</u>
   f. ROW Acquisition = <u>$50/SF</u>

2. **Replace Roadway with 5-lane Typical Section, Option 2**
   a. Roadway = $6,066,000/mile
   b. Striping = $75,000/mile
   c. Signing = $25,000/mile
   d. Storm Sewer = $1,800,000/mile
   e. Total: <u>$7,966,000/mile</u>
   f. ROW Acquisition = <u>$50/SF</u>

3. **Restripe lanes for 'Truck Friendly' configuration, Option 3**
   a. Striping = $75,000/mile
   b. Signing = $25,000/mile
   c. Total: <u>$100,000/mile</u>

4. **Replace Roadway with 2-lane Typical Section, Option 4**
   a. Roadway = $4,468,000/mile
   b. Striping = $75,000/mile
   c. Signing = $25,000/mile
   d. Storm Sewer = $1,000,000/mile
   e. Total: <u>$5,568,000/mile</u>
   f. ROW Acquisition = <u>$50/SF</u>

TEXAS DEPARTMENT OF TRANSPORTATION

FY 15 Average Unit Cost

State FY 2015 Low Bid Average for New and Replaced Bridges with DCIS Estimate

Length, LF	20-50		51-100		101-200		201-400		401-1000		>1000		Average	Total Number
Type	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	#	$/SF	$/SF	#
CLV	40	88.0	13	75.0	3	68.6							**80.9**	56
GP-BX			11	142.0	4	112.0	2	146.4					**133.4**	17
GPDSB			5	144.1	1	265.3							**188.9**	6
GP-I					1	78.4	3	71.2			1	64.2	**68.9**	5
GPITX	2	88.0	33	103.8	40	83.4	63	64.0	32	69.1	22	58.5	**64.7**	192
GP-U									2	63.1			**63.1**	2
GPXBX			2	116.6	2	77.9							**92.2**	4
GS-I			1	117.2			4	151.6	7	146.7	2	137.9	**144.9**	14
GS-TR									1	138.2			**138.2**	1
PCSB	34	113.7	27	111.4	16	112.4	6	97.5	1	69.4			**104.4**	84
SLAB			1	85.0	1	121.2							**104.3**	2
STRTR*					1	1008.8							**1008.8**	1

Legend
CLV - Bridge Class Culvert
GP-BX - Girder Prestressed "Box" Beam
GPDSB - Girder Prestressed Decked Slab Beam
GP-I - Girder Prestressed "I" Beam
GPITX - Girder Prestressed "I" Texas Shape
GP-U - Girder Prestressed "U" Beam
GPXBX - Girder Prestressed "X Box"
GS-I - Girder Steel "I" Beam
GS-TR - Girder Steel Trapezoidal
PCSB - Prestressed Concrete Slab Beam
SLAB - Slab Cast in Place
STRTR* - Structural Truss in this case RR plate truss

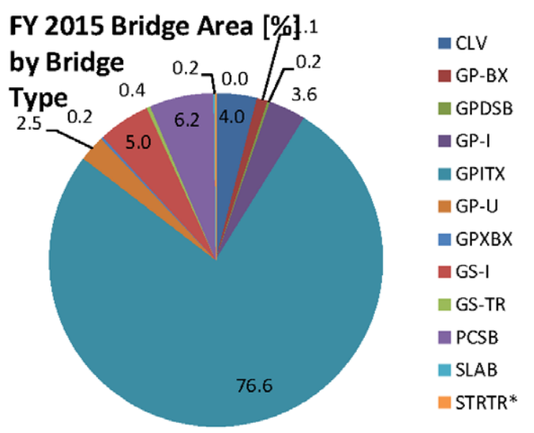
Note: # is a number of whole or portions of a bridge of certain type. In this case 384 represent 374 bridges.

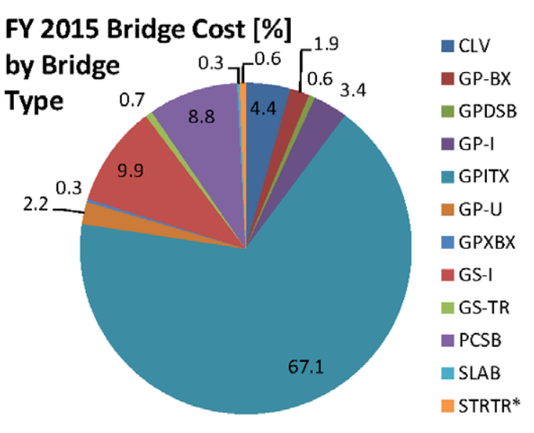
FY 15 Average Unit Cost

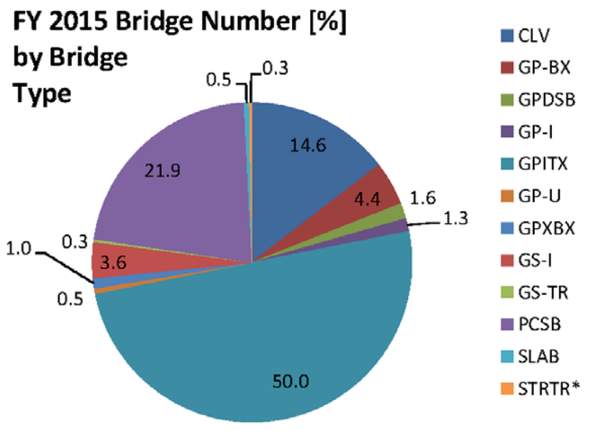
State FY 2015 Low Bid Average for New and Replaced Bridges with DCIS Estimate																								
Type	average $/SF			Area								Cost						Number						
	On	Off	Total	On			Off			Total	Total	On		Off		Total	Total	On		Off		Total	Total	
	$/SF	$/SF	$/SF	SF	avg SF	%	SF	avg SF	%	SF	%	$	%	$	%	$	%	#	%	#	%	#	%	
CLV	77.3	109.7	**80.9**	196,560	5,312	88.7	25,053	1,319	11.3	221,613	4.0	15,188,869	84.7	2,747,157	15.3	17,936,026	4.4	37	66.07143	19	33.92857	56	14.6	
GP-BX	105.1	155.6	**133.4**	25,756	6,439	43.9	32,932	2,533	56.1	58,687	1.1	2,708,036	34.6	5,123,365	65.4	7,831,401	1.9	4	23.52941	13	76.47059	17	4.4	
GPDSB	231.8	140.9	**188.9**	7,000	3,500	52.9	6,240	1,560	47.1	13,240	0.2	1,622,280	64.9	879,211	35.1	2,501,491	0.6	2	33.33333	4	66.66667	6	1.6	
GP-I	67.5	78.3	**68.9**	174,789	43,697	87.2	25,600	25,600	12.8	200,389	3.6	11,804,724	85.5	2,004,199	14.5	13,808,923	3.4	4	80	1	20	5	1.3	
GPITX	63.4	97.3	**64.7**	4,106,786	25,195	96.3	156,473	5,396	3.7	4,263,259	76.6	260,551,378	94.5	15,225,063	5.5	275,776,441	67.1	163	84.89583	29	15.10417	192	50.0	
GP-U	63.1	-	**63.1**	140,979	70,490	100	-	-	0.0	140,979	2.5	8,899,468	100	-	0.0	8,899,468	2.2	2	100	0	0	2	0.5	
GPXBX	92.2	-	**92.2**	12,920	3,230	100	-	-	0.0	12,920	0.2	1,191,059	100	-	0.0	1,191,059	0.3	4	100	0	0	4	1.0	
GS-I	145.1	117.2	**144.9**	278,213	21,401	99.2	2,240	2,240	0.8	280,453	5.0	40,363,159	99.4	262,468	0.6	40,625,627	9.9	13	92.85714	1	7.142857	14	3.6	
GS-TR	138.2	-	**138.2**	20,240	20,240	100	-	-	0.0	20,240	0.4	2,796,125	100	-	0.0	2,796,125	0.7	1	100	0	0	1	0.3	
PCSB	96.0	111.1	**104.4**	191,189	5,975	55.4	153,966	2,961	44.6	345,155	6.2	21,241,099	59.0	14,777,388	41.0	36,018,487	8.8	32	38.09524	52	61.90476	84	21.9	
SLAB	85.0	121.2	**104.3**	4,600	4,600	46.6	5,276	5,276	53.4	9,876	0.2	391,000	38.0	639,167	62.0	1,030,167	0.3	1	50	1	50	2	0.5	
STRTR*	1009	-	**1009**	2,268	2,268	100	-	-	0.0	2,268	0.0	2,287,943	100	-	0.0	2,287,943	0.6	1	100	0	0	1	0.3	
ALL N&R			**$73.7**							**5,569,079**						**410,703,158**		**264**		**120**		**384**		
All N&R -CLV			**$73.4**							**5,347,466**						**392,767,133**		**227**		**101**		**328**		

The only OFF GS-I was a rolled beam, not "I" welded girder like the ON bridges.

TEXAS DEPARTMENT OF TRANSPORTATION







Legend		
CLV	-	Bridge Class Culvert
GP-BX	-	Girder Prestressed "Box" Beam
GPDSB	-	Girder Prestressed Decked Slab Beam
GP-I	-	Girder Prestressed "I" Beam
GPITX	-	Girder Prestressed "I"Texas Shape
GP-U	-	Girder Prestressed "U" Beam
GPXBX	-	Girder Prestressed "X Box"
GS-I	-	Girder Steel "I" Beam
GS-TR	-	Girder Steel Trapezoidal
PCSB	-	Prestressed Concrete Slab Beam
SLAB	-	Slab Cast in Place
STRTR*	-	Structural Truss in this case RR plate truss

C.5 Cost Model Examples

C.5.1 Precinct 1 – Rankin Road

- **Level 1 Route Description**

  The existing Level 1 Route from IH-45 to Aldine Westfield Road consists of two sections:

  1. A four-lane undivided asphalt section with open ditch drainage from IH-45 to East Hardy Road.
  2. A four-lane divided boulevard concrete pavement section with curb and gutter drainage from East Hardy Road to Aldine Westfield Road.

  This county road provides east-west access from IH-45 to various commercial and industrial developments west of George Bush Intercontinental Airport. The potential for future expansion of industry is significant, due to close proximity to the expanding airport.

- **Current Condition of Facility**

  The current roadway pavement is in fair condition. The roadway consists of a boulevard section from East Hardy Road to Aldine Westfield Road with 24' wide pavement in each direction of travel with right and left turn lanes at major intersections. The pavement width varies from 46' to 58' (approximate) from IH-45 to East Hardy Road. The close proximity of open ditch drainage systems on both sides is a safety concern. The facility needs to be upgraded to current county standards for a major thoroughfare.

- **Proposed Improvements**

  Based on the existing right of way width, Typical Section 2 was applied to Rankin Road from IH-45 to East Hardy Road. The length of this segment is approximately 1.61 miles. The total estimated construction cost to improve this segment is $13 million.

Figure C.5 Rankin Road

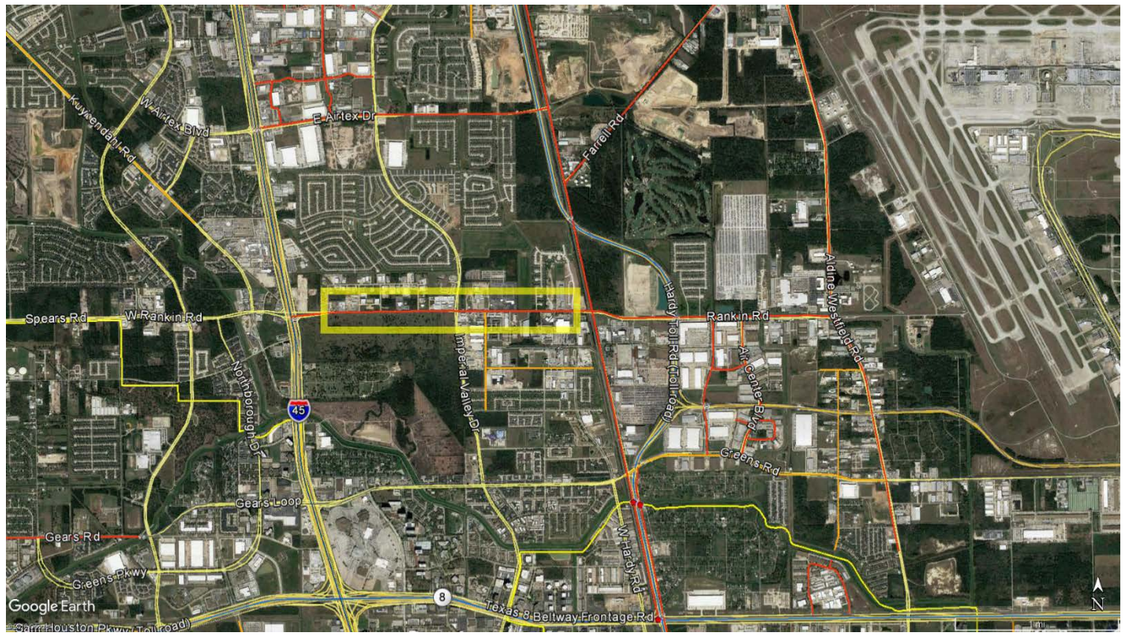


Figure C.6 Rankin Road Street View

C.5.2 Precinct 2 – Sheldon Road

- **Level 1 Route Description**

  The existing Level 1 Route from IH-10 to Jacintoport Boulevard consists of two sections:

  1. A four-lane divided boulevard concrete pavement section with curb and gutter drainage from IH-10 to Market Street.
  2. A two-lane undivided asphalt section with open ditch drainage south of Market.

  This county road provides direct north-south access from IH 10 to Jacintoport Boulevard and industrial facilities north of the Ship Channel. The potential for future expansion of industry is significant, due to easy access to interstate to major tracts of land available for development, including available utilities and other infrastructure.

- **Current Condition of Facility**

  The current roadway pavement is in fair condition. The roadway consists of a boulevard section from IH-10 south to Market Street with 24' wide pavement in each direction of travel. The roadway consists of 34' wide pavement (approximate) from Market to Jacintoport. One lane in each direction south of Market without paved shoulders limits the traffic-carrying capacity of the facility. The close proximity of open ditch drainage systems on both sides is a safety concern. The facility needs to be upgraded to current county standards for a major thoroughfare.

- **Proposed Improvements**

  Based on the existing right of way width, Typical Section 1 was applied to Sheldon Road from Market Street to Jacintoport. The length of this segment is approximately 1.55 miles, and includes a 200-foot bridge over a tributary to the Houston Ship Channel. The total estimated construction cost to improve this segment is $17 million.

Figure C.7 Sheldon Road

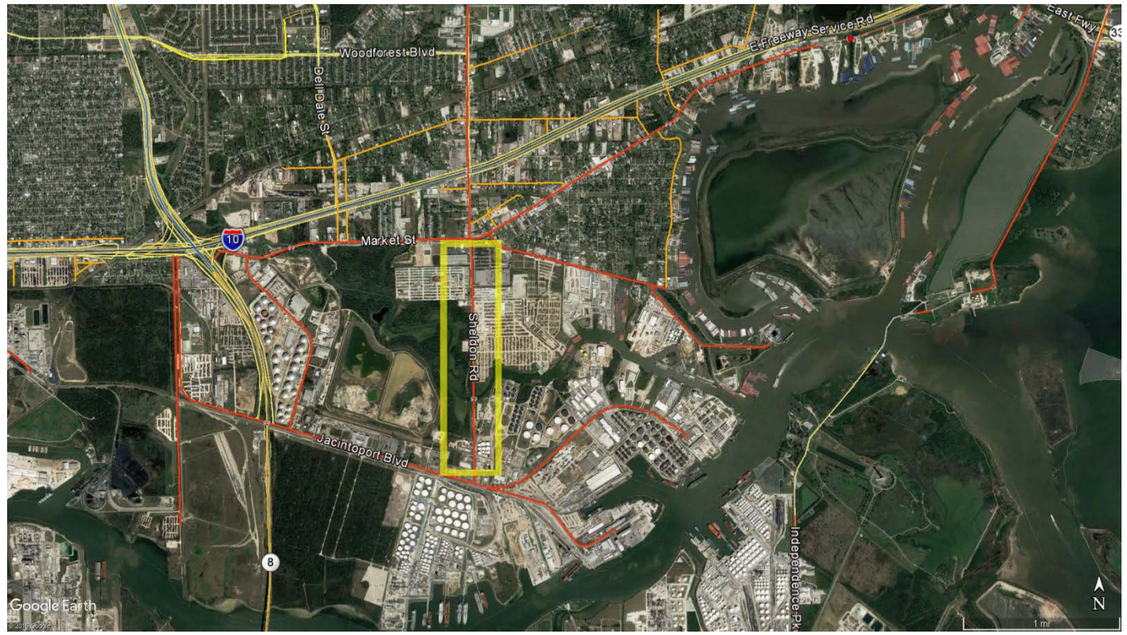


Figure C.8 Sheldon Road Street View

C.5.3 Precinct 3 – Katy Hockley

- **Level 1 Route Description**

  The existing Level 1 Route intersecting US 290 in western Harris County consists primarily of a narrow two-lane asphalt roadway. This county road provides north-south access to property adjacent to US 290. The surrounding area is not significantly developed, but has a high potential due to the expansion of US 290 and the newly constructed Grand Parkway.

- **Current Condition of Facility**

  The current roadway pavement is in poor condition. The roadway consists of deteriorating asphalt pavement, with widths ranging from 20' to 24'. The existing roadway is inadequate for truck traffic.

- **Proposed Improvements**

  Based on the existing right of way width, Typical Section 4 was applied to one mile of Katy Hockley Road south of US 290. The total estimated construction cost to improve this segment is $5.6 million.

Figure C.9 Katy Hockley

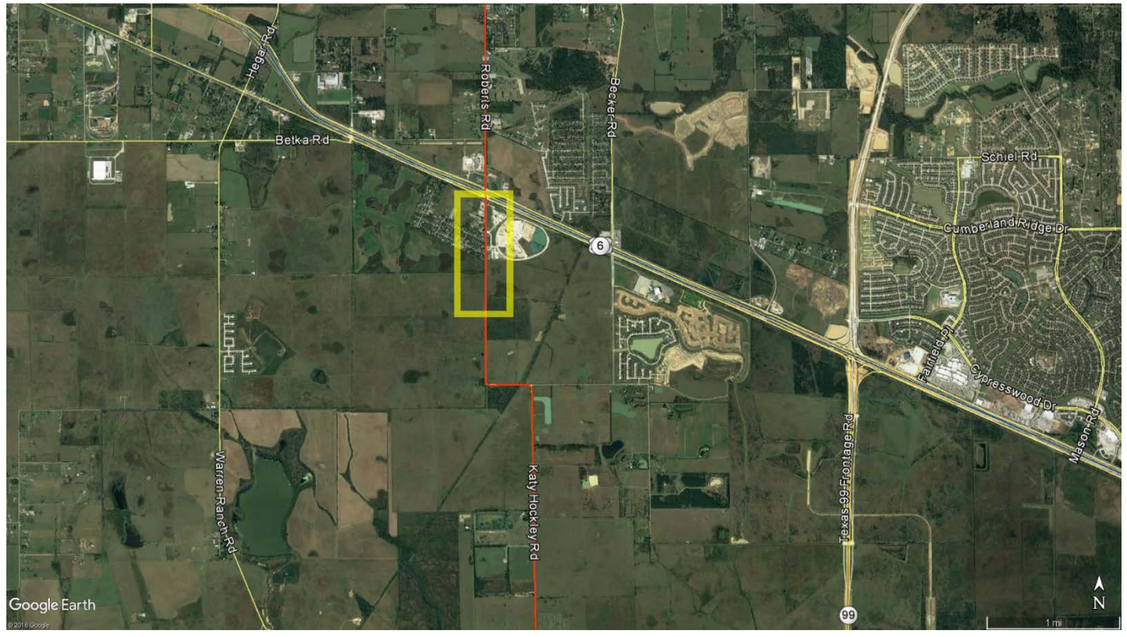


Figure C.10 Katy Hockley Street View

C.5.4 Precinct 4 – Tanner Road

- **Level 2 Route Description**

  The existing Level 2 Route intersects the Sam Houston Toll Road south of US 290, and consists of varying roadway sections. The area is highly developed with commercial and industrial properties.

- **Current Condition of Facility**

  The current roadway west of the Sam Houston Toll Road is in fair condition. The roadway consists of a boulevard section immediately west of the Toll Road, and transitions to a five-lane asphalt road with a two-way left-turn lane west of Brittmore Road. The current roadway east of the Toll Road is in poor condition. The two-lane asphalt roadway has narrow lanes without shoulder, open ditch drainage, and multiple utilities.

- **Proposed Improvements**

  Based on the existing right of way width, Typical Section 4 was applied to Tanner Road from the Sam Houston Toll Road to Gessner Road. The length of this segment is approximately 1.08 miles. The total estimated construction cost to improve this segment is $6 million.

Figure C.11 Tanner Road

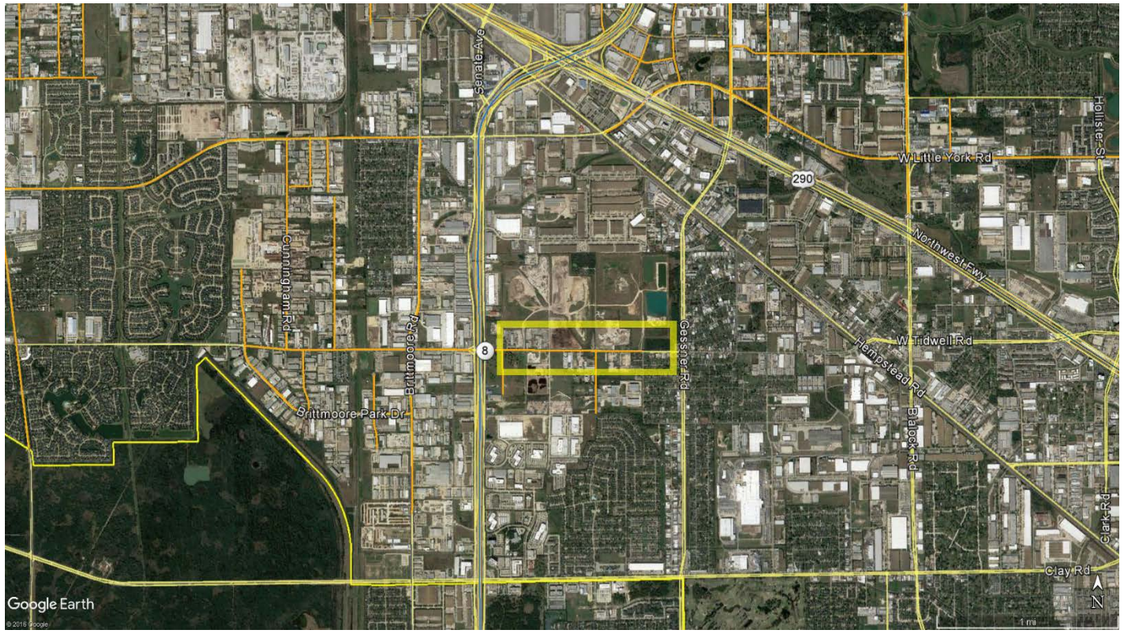


Figure C.12 Tanner Road Street View